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Efficiency of Bankrupt Firms and Industry Conditions: Theory and Evidence

by
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October 19, 1996

'University of Maryland, College of Business and Management, College Park, MD 20742-1815. We thank Judy Chevalier, John Graham, Charles Hadlock, Marc Lipson, Pegaret Pichler, Jay Ritter, David Scharfstein, Alex Triantis, Sheridan Titman, an anonymous referee, the editor Rene Stulz and seminar participants at Boston College, University of Chicago, Columbia, Georgia, MIT, NBER, North Carolina, SMU, Tulane, UBC, Utah and Virginia for helpful comments. We also thank Suzanne Peck, Bob McGuckin and researchers at the Center for Economic Studies for data help and discussions on this project. This work was conducted at the Center for Economic Studies, U.S. Census Bureau where the 2nd author was a ASA/NSF research fellow. The authors can be contacted by E-mail at max@bmgmtmail.umd.edu and gphillips@bmgmtmail.umd.edu respectively.

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Abstract

We show that the incentives to reorganize inefficient firms and redeploy their assets depend on the change in industry output and industry characteristics. We use plant-level data to investigate the productivity of Chapter 11 bankrupt **firms** and asset-sale and closure decisions. We find no evidence of bankruptcy costs in industries with declining output growth, where most bankruptcies **occur**. In declining industries, bankrupt firms' plants are *not* less productive than industry averages and do not decline in productivity while in Chapter 11. In these industries, Chapter 11 appears to be a mechanism for fostering exit of capacity. In high-growth industries, there is some limited evidence of productivity declines while in Chapter 11 for a subsample of firms that remain in Chapter 11 for four or more years. Examining asset sales and closures by bankrupt firms and their competitors, we find that Chapter 11 status is of limited importance in predicting these decisions once industry and plant characteristics are taken into account. More generally, the findings imply that Chapter 11 may involve few real economic costs, and that industry effects and sample selection issues are very important in evaluating the performance of bankrupt **firms**.

Key Words: Bankruptcy, Total Factor Productivity, Industry Equilibrium.

1. Introduction

A key question in the corporate finance literature is whether Chapter 11 bankruptcy provides a mechanism by which insolvent firms are efficiently reorganized and the assets of unproductive firms are effectively redeployed. The literature has focused on whether Chapter 11 bankruptcy and the bargaining between claimants to the firm's assets leads to efficient reorganizations. The effect of industry demand and supply conditions on the value of reorganization and real bankruptcy costs has received less attention. In this paper, we examine how industry conditions affect the productivity of bankrupt firms and their decisions to sell or scrap assets.

Our model shows the incentives of firms to sell or close assets depend on industry demand and the amount of productive capacity in the industry. Using a sample of 1195 plants of 302 firms that declared Chapter 11 and over 50,000 plants of non-bankrupt firms - representing both public and private firms in the US manufacturing sector - we examine the importance of industry, firm and plant-level factors to manufacturing productivity, asset sales and plant closures.

Our paper is related to two central issues in bankruptcy research: the costs of bankruptcy and the factors influencing sales and closures of assets of Chapter 11 firms. As pointed out by Haugen and Senbet (1978), the costs of bankruptcy reorganization *per se* are unlikely to be significant.² Several recent papers, among them Harris and Raviv (1990), Diamond (1993), Jensen (1993), and Hart and Moore (1995), argue that bankruptcy can even be beneficial *as* a trigger that effects a change in control of the firm and the termination of unprofitable projects. By contrast, Giammarino (1988) and Bergman and Callen (1991) have identified potential conflicts that, if unresolved, may cause the firm not to maintain, sell or close assets optimally.³ We provide evidence on whether bankruptcy facilitates the redeployment of assets when they are not used efficiently by firms.⁴

²For a review of the literature on bankruptcy costs see Altman (1993) or Seward and Senbet (1995). Warner (1977) and Weiss (1990) examine the direct costs (lawyers, accountants) of bankruptcy. Andrade and Kaplan (1996) also report low real costs of financial distress for a sample of highly leveraged firms.

³The resolution of bankruptcy is further complicated by coalition formation between different classes of investors (Bulow and Shoven (1978), Gertner and Scharfstein (1991)).

⁴Related literature has considered asset sales by firms. Rajan (1992), Diamond (1993), Brown, James, and Mooradian (1993) have considered how the presence of financial intermediaries (who have a comparative advantage in monitoring) among debtors in bankruptcy will affect the resolution of claims and the disposal of the bankrupt firm's assets. Bolton and Scharfstein (1993) allow for partial liquidation and value of the assets to be stochastic.

Central to our model is the simple idea that industry conditions affect the marginal product of capital and, thus, the incentives to disinvest and redeploy assets. In declining demand industries where the marginal product of capacity is low, bankruptcy may result from excess industry capacity as well as from firm inefficiency. In high-growth industries, relative firm efficiency may be more important to asset redeployment. If there are agency costs, then the redeployment may not occur optimally. In particular, in high-growth industries, inefficient firms may have sufficient cash flows to continue to operate assets despite high gains to asset transfers.

Our empirical results show that industry effects are important determinants of the frequency of bankruptcy and economic decisions in bankruptcy. We find that there are more than three times the proportion of plants of Chapter 11 firms in low growth industries as in high growth industries. However, in low-shipment growth industries the productivity of plants while in Chapter 11 bankruptcy and subsequent to emerging does *not* significantly differ from that of their industry counterparts. These plants also do not decline in productivity during Chapter 11. Thus, Haugen and Senbet's contention that there are no indirect bankruptcy costs is supported in these industries where most Chapter 11 bankruptcies occur.

The detailed plant-level census manufacturing data we use enables us to examine how the composition of bankrupt firms changes as they make marginal decisions - to retain, sell or close plants. After controlling for asset sales and closures, we find significant declines in productivity only for plants in high growth industries that immediately exit Chapter 11 or remain in Chapter 11 for four or more years. Thus, bankruptcy costs and the effectiveness of a reorganization cannot be evaluated by examining only the performance of the survivor firm.

We directly examine asset sales and closures by both Chapter 11 firms and industry competitors. There is little evidence that Chapter 11 facilitates asset sales by less efficient firms. Bankrupt firms do sell plants at a higher rate than non-bankrupt firms. However, for the most part, this difference is accounted for by sample selection and industry conditions and *not* by bankruptcy status. Although the probability of an asset sale is not strongly affected by bankruptcy status, we do find that in high growth industries the plants that are sold by bankrupt firms experience a subsequent increase in productivity.

For the sub-sample of plants in declining industries, Chapter 11 status is associated with a higher probability of closing a plant. This increased probability is caused by a greater sensitivity to the change in industry shipments rather than any increased tendency to weed out inefficient plants. These findings suggest that Chapter 11 bankruptcy has a greater role

in promoting the exit of capacity from declining industries than in changing the incentives for firms to dispose of inefficient plants.⁵

The empirical analysis in our paper is related to the study of bankruptcy outcomes by Hotchkiss (1995), and the study of pre-bankruptcy asset sales by Khanna and Poulsen (1995). We differ from these papers in several key respects. First, we embed the bankruptcy process in an industry equilibrium setting that yields predictions about the frequency and resolution of bankruptcy. Second, **our** data enables us to examine the performance and to track the closures and sales of individual plants, rather than of the firm as a whole. Third, our sample also includes firms that do not emerge from Chapter 11 bankruptcy protection. An implication of our results is that one cannot evaluate endogenous changes in corporate governance (boards of directors, managers) on bankrupt firms without explicitly considering the industry environment.

The paper is also part of a group of articles that considers the industry environment and the interaction of firms' asset sale and exit decisions with their environment.⁶ The effect of demand conditions on the reorganization of insolvent firms has been recognized by Shleifer and Vishny (1992).⁷ They focus on asset sales and on how liquidation value depends on the cash reserves of firms in the same industry. The intuition behind their model is that informational asymmetries prevent the bankrupt firm from realizing the full value of its assets because of the likelihood that the most informed purchasers are also in financial distress. Our approach differs because we focus on whether economically efficient sales and closures occur and do not model the gains and losses of the various parties.

The rest of the paper is organized as follows. Our framework is discussed in Section 2. We discuss data and our methodology in Section 3. Section 4 contains results on firm productivity and the bankruptcy process. Section 5 concludes the paper. All the formal proofs are in the Appendix.

⁵A related finding, by Morck, Shleifer and Vishny (1989), is that hostile takeovers are used to discipline managers in poorly performing industries, but alternative mechanisms are used in healthy industries.

⁶Papers in this group include Maksimovic and Zechner (1994), Chevalier (1995), and Kovenock and Phillips (1995).

⁷Lang and Stulz (1992) have examined the stock price reactions to bankruptcy announcements by firms within the same industry. They examine the information content of the announcement rather than the efficiency of reorganizations.

2. Bankruptcy in an Industry Equilibrium

To provide a benchmark for our empirical analysis of bankrupt firms, we first develop a simple model of how productivity, asset sales and closures depend on industry conditions. We then use this model to predict the characteristics of firms that become bankrupt in high and low growth industries and to identify possible costs of bankruptcy.

Most models of optimal capacity liquidation in finance, such as Harris and Raviv (1990), analyze financial structures that induce firms to liquidate unproductive capacity. In this single firm analysis, the opportunity cost of capacity is taken as exogenous, and it is optimal to liquidate a plant when its productivity falls below the firm's marginal gain from operating it.⁸ Hence, the analysis suggests that there is a critical value of the asset's marginal product below which it is optimal to liquidate it, and above which it is optimal to retain it.

In multi-firm industry settings the firm's capacity decision is more complex. At any time there may be firms with different cost structures producing in the industry. These differences may occur because different firms may choose investments that minimize costs in different industry demand conditions or because entrepreneurs may discover that their chosen product market strategy has worked out better or worse than expected. If industry demand changes, the comparative advantages of firms may alter and it may become optimal for some firms to scrap capacity. However, a less productive firm also has the alternative of liquidating capacity by selling it to those firms that have a comparative advantage in producing under the new conditions. The gain from selling a unit of capacity to other firms in the industry depends on the difference between the profits firms with different cost structures can realize from a marginal unit of capacity. This difference is endogenously determined and depends on industry conditions. Importantly, the demand conditions in which it is optimal to liquidate assets by selling them to other firms may not be the same for each firm.

How do industry conditions affect which firms enter bankruptcy and costs in bankruptcy? If bankruptcy is used as a trigger to force firms to optimally liquidate assets, the quality of firms going into bankruptcy may systematically vary with industry demand conditions. The type and relative magnitude of bankruptcy costs, if they exist, may also depend on the level of industry demand. In high demand industries the cost may be a failure to sell plants when productivity under alternative ownership is higher. In low demand industries the cost may be a failure to close.

⁸Dynamic models, such as Brennan and Schwartz (1985) take into account the option value of retaining capacity. However, they also take the liquidation value as given.

2.1 Optimal closures and asset transfers

We first examine the optimal transfer of assets between firms in an industry with firms of differing levels of productivity. Our model makes two points. First, high quality firms close down when their operating value falls below their salvage value. By contrast, the opportunity cost of capacity operated by a low quality firm can be either the salvage value of capacity or the value of selling out to high quality firms. As a result, the liquidation decisions of high and low quality firms depend in different ways on the level of demand. Second, the total firm value and the optimal output produced by the firm are always positively related for high quality firms, but may be negatively related for low quality firms.

We make three key assumptions in order to focus on the effect of differences in efficiency between firms on their optimal capacity. First, the level of demand is random and when demand uncertainty is resolved the price of capacity adjusts to clear the market. Second, we assume that firms differ in their ability to obtain output from assets. Specifically, we assume that there are two types of firms: high and low quality firms. The firms discover their types only after the initial distribution of capacity is given. A proportion π of firms are high quality firms and produce one unit of output per unit of capacity. The remaining $1 - \pi$ of the firms produce only d ($d < 1$) units of output per capacity unit.

Third, we assume that the firms face increasing costs of supervision and management as their size increases beyond an efficient minimum scale.⁹ Firms use a variable input, called labor, together with capacity units to produce output. As capacity increases beyond the minimum efficient scale, firms exhibit neoclassical decreasing returns to scale, so that their marginal costs increase with output. Specifically, for ease of exposition we assume that a firm with k ($k \geq 1$) units of capacity faces variable costs of wk^2 to operate each period, where w is a positive constant that depends on the cost of labor and other inputs that all firms use.

In addition to these key assumptions that drive our model, we also make several assumptions that enable us to illustrate the issues in a tractable framework. The initial number of firms n in the industry is given.¹⁰ Each firm initially owns an exogenously given production capacity k . Total initial capacity is given as K . Firms are assumed to be price-takers and all produce a homogenous output. The market price that the customers pay for the output

⁹See Coase (1937) and Lucas (1978), for example, for analyses of such diseconomies of scale. For empirical support of decreasing returns to scale see Brock and Evans (1986). Decreasing returns to scale is the simplest assumption that determines a distribution of firm sizes in conjunction with price taking behavior.

¹⁰At the end of this section we discuss how the entry of new firms may affect asset transfers.

is determined as $p = a - bQ$, where Q is the aggregate production, a is a positive random variable and b is a positive constant. We also assume that the opportunity cost of funds is constant. To minimize notation this constant is taken to be zero.

There are three dates: $t_i, i = 0, 1, 2$. At time t_0 , the firms learn the level of demand in the industry and their quality relative to other firms. The level of demand a is revealed at time t_0 and remains constant thereafter. At time t_1 each firm has a choice of (i) using its entire capacity to produce; (ii) shutting down and selling all its capacity to other firms in the same industry or for scrap, (iii) selling some capacity and using the remainder to produce, (iv) buying capacity from other firms and producing or (v) buying new capacity from an external market. Capacity has a scrap value of s at time t_1 and that capacity has no value at time t_2 . We also assume that the scrap value is sufficiently low so that both high and low quality firms wish to operate for at least some demand levels.

The price of one unit of capacity in a perfect market for capacity units at time t_1 is equal to τ . At time t_1 , if the price of capacity in the secondhand market, τ , exceeds s , new capacity can be purchased from the external market, with the price given by an upward sloping inverse supply curve, $c = \alpha + \beta\tau$, $\alpha, \beta > 0$, where c is the total quantity of new capacity purchased.¹¹ At time t_2 the firms that elected to remain in the industry realize the profits from producing in the first period.

Because firms' average costs increase with size, there is an equilibrium distribution of firm sizes. In equilibrium, firms will trade capacity units until the marginal value of each capacity unit is the same in each firm. For a given capacity, high quality firms produce more output than low quality firms and, therefore, their marginal unit of capacity has a higher value. As a result, in equilibrium high quality firms are larger than low quality firms.

The optimal distribution of capacity depends on the value of the additional output that the high-quality firms can produce with each unit of capacity. As demand increases, and the value of this additional output increases. The high-quality firms in the industry acquire additional capacity. This process continues until the increase in the value of output, that occurs when a unit of capacity is transferred from a low-quality to high-quality firm, just equals the net increase in the costs of supervision.

In the following proposition, we characterize the optimal operating policies of high and

¹¹Thus, we are assuming adjustment costs or that the supply of capacity is not perfectly elastic. In a world in which investment instantaneously adjusts to demand conditions without increasing the marginal cost of new investment, the considerations we model are not important. In this case Tobin's Q of all firms would be equal to one.

low quality firms as demand varies.

Proposition *Assume that the opportunity cost of capacity outside the industry is sufficiently low so that it is optimal for both high and low quality firms to operate for some feasible level of demand. If the difference in productivity between high and low quality firms is sufficiently big (more precisely, if $d < \frac{1}{\alpha}$), then at t_1 :*

(1) In industries where demand is sufficiently high the low quality firms sell all their capacity units to high quality firms and exit the industry.

(2) For industries where demand is at intermediate range, both high and low quality firms produce. At the high end of this intermediate range low quality firms sell capacity units to high quality firms. At the low end of this range, both types of firms may sell capacity for salvage.

(3) In industries where demand is sufficiently low, both high and low quality firms sell all their capacity units for salvage and exit the industry.

Proof: See appendix.

These results show that if the productivity differences between firms are sufficiently large, then as the demand level increases, the difference in the value of their product can become so large that it is more efficient to shut down the low quality firms and transfer their assets to high quality firms. The more inelastic the supply of new capacity, the lower the level of demand at which low quality firms sell off all their assets.¹²

The optimal firm size distribution characterized in the proposition implies that high and low quality firms have different optimal liquidation policies. They are formally stated in the following corollary:

Corollary *For low quality firms there are two disjoint intervals of demand levels in which it is optimal to liquidate the firm's operations totally. In one of the intervals both demand and firm value are low whereas in the other interval both are high. It is only optimal to liquidate high quality firms when the level of demand and their value is low.*

The relationship between the value of the firm and the amount of capacity operated by the firm is different for the two types of firms. With high quality firms the two increase monotonically with demand. By contrast, with low quality firms, at high demand, value is maximized by selling capacity. Thus, if firms are managed by agents whose compensation depends on the amount of capacity they control, the interest of the agents and owners will

¹²The value of low quality firms still increases with demand as they sell off their capacity. The firm's value is the sum of the market value of the firm's assets and the firm's profits from operations.

be directly opposed when demand is high and the firm is of low quality.

In the long run, entry of new firms or increased investment by existing firms can affect the transfer of assets as demand changes. For sufficiently high demand new firms may enter the industry or existing firms may find it profitable to construct additional capacity. Over time, entry of new firms and the construction of new capacity by high quality existing firms would displace existing firms known to be of low quality. If the attributes of high quality firms do not change over time, then as in Jovanovic (1982), the firms in the industry would become more homogeneous as the low quality firms were weeded out and the industry attained a long-run equilibrium. In such a long-run equilibrium transfers of capacity between more and less efficient firms would not be material. However, if over time the comparative advantage shifts among firms as a result of technological change or changes in consumer preferences, then transfers of assets between firms would persist in the long run, and would be affected by changes in the level of demand that we model.¹³

2.2 Bankruptcy and Liquidations

Bankruptcy and financial structure fit into this framework as tools to promote optimal liquidation when the firm is controlled by agents who may not maximize firm value. We next discuss how financial structures that facilitate value maximization determine the characteristics of the firms that become bankrupt at different levels of demand. Below, we use these predictions to motivate empirical tests of bankruptcy costs: we test whether bankruptcy status affects the likelihood that a firm engages in value maximizing transfers predicted by the model.

Several recent contributions to the literature argue that corporate insiders have incentives to continue the firm's operations when full or partial liquidation maximizes the value of the corporation (see for example, Harris and Raviv (1991), Diamond (1993) and Hart and Moore (1995)). If such conflicts exist, then financial structures that force the firm into bankruptcy when liquidation maximizes the firm's value may be optimal.

¹³The importance of capacity transfers would be reduced if existing high-quality firms can acquire new capacity by building it, rather than by buying it from lower quality firms. This generalization would not affect the qualitative results above if the price of new capacity increases when industry demand is high. If the price of new capacity is independent of demand, then the price of capacity would be completely exogenously determined, and would not affect the distribution of firm sizes. In practice, such perfect adjustment is unlikely. Unexpected demand shocks, convex costs of adjustment and fixed costs of entry into the industry introduce frictions into the adjustment process. The assumption that there exists convex adjustment costs of adding new capacity is thoroughly documented in Cabellero, Engel, and Haltiwanger (1995).

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1. Introduction

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Liquidation policy must address two different outcomes, closures when demand is low and asset transfers when demand is high. Consider first the liquidation region in which demand is low and it is optimal to close the firm and sell its assets for salvage. Optimal liquidation can be effected by a debt structure that causes the firm to become insolvent when its value is low. Such policies affect optimal liquidation for both high and low quality firms since the values of the two types of firms converge for low demand. Closure of some firms may be optimal, not only because of relative firm inefficiency, but also because of excess industry capacity relative to demand.

Second, consider when demand is high and the optimal liquidation policy is for inefficient firms to sell their capacity to efficient firms. This second liquidation region occurs when an inefficient firm's value from continuing operations is less than the value of its assets to high quality firms. If there exist costs of financial distress or bankruptcy, it is costly to enforce liquidation in this region by the choice of an appropriate financial structure. Enforcement is difficult because in this region the overall level of industry cash flows is high. At levels of debt high enough to ensure liquidation, both efficient firms and inefficient firms may also become insolvent if the realized demand is lower. As a result, it is optimal to enforce liquidation in this region only if the costs of insolvency for firms that should not be liquidated are low, or if the low quality firms are so inefficient that their operating profit is very low even at high levels of demand.

Several predictions, that we subsequently test empirically, can be drawn from this discussion of asset redeployment in an industry setting:

First, if there are costs of insolvency, debt levels are set to force both high and low quality firms into bankruptcy when demand is low and to force only low quality firms that are very inefficient into bankruptcy when demand is high. For any fixed debt level, there will be a higher incidence of bankruptcy in low demand industries. If there are no significant costs of insolvency, then debt levels are set sufficiently high to force even moderately inefficient low quality firms into bankruptcy at high demand. Thus, in the former case the population of bankrupt firms in low demand industries is close to a cross-section of the industry as a whole, whereas the population of firms that are bankrupt in high demand industries is significantly less efficient than the industry average. The greater the costs of insolvency, the greater the difference in efficiency between the population of bankrupt firms and the industry average in high demand industries.

Second, conflicts between claimants are likely to be more severe in high demand industries because the opportunity cost of the firm's assets is higher when the demand is high. Thus,

costs of bankruptcy, if they exist, are also likely to be higher when industry demand is high than when industry demand is low.

Third, the model predicts that an important class of potential agency costs in bankruptcy to be considered in high demand industries is the failure to sell assets to other firms in the industry as soon as it is efficient to do so. We can determine whether this economic cost may exist by comparing productivity under new ownership of assets for bankrupt and non-bankrupt firms in high demand industries.¹⁴

Fourth, the model predicts that a potentially important bankruptcy cost in low demand industries may be the failure to liquidate assets by closing them as soon as it is efficient to do so. The existence of this cost may be measured by comparing the closure decisions of bankrupt and non-bankrupt firms in low demand industries.

Fifth, the observation, made by Hotchkiss (1995), that firms that emerge from bankruptcy are less profitable and are smaller than non-bankrupt firms does not *necessarily* imply that the bankruptcy process has failed. As the above results suggest, over some demand ranges it may be efficient for at least some low quality firms to remain in the industry.¹⁵

3. Empirical Analysis: How Important are Industry Conditions?

We explore the previous predictions about how industry demand and supply conditions, along with firm factors, influence the productivity and investment decisions of firms in Chapter 11. Our null hypothesis is that value maximizing transfers occur and are related to demand and productivity conditions, and that there are no bankruptcy costs. We investigate both long-run changes in industry shipments and short-run changes in aggregate industry investment to examine whether inefficient firms file for Chapter 11 and whether industry demand and supply conditions influence the outcomes of the bankruptcy process. The outcomes examined include asset sales, plant closures and reorganizations. The detailed micro-level plant data we use allows us to control for this changing asset composition and compare the productivity of assets before, during, and after emergence from Chapter 11.

¹⁴This yields a lower bound because we do not know how many value maximizing asset sales do not occur because they are prevented by agency conflicts.

¹⁵In a multi-period model there would be an even larger benefit to low quality firms remaining in the industry, operating at the minimum scale and selling surplus assets. This benefit would arise from the option value of remaining in the industry and gaining from either an increase in demand or an improvement in the firm's own efficiency. This effect is akin to the option value of not closing a loss-making mine in Brennan and Schwartz (1985).

3.1 Data

We examine a sample of 302 firms that filed for Chapter 11. The firms had to satisfy two basic criteria for inclusion in our sample. First, the firm had to be a manufacturing firm producing products in SIC codes 2000-3999. Second, the bankruptcy had to occur in the years 1978-1989. Both of these requirements arise because of the unique nature of the micro-level data that we use to analyze plant-level productivity. The sample and tests do include firms which declared Chapter 11 reorganization and subsequently changed status to Chapter 7. We thus include all firms while in Chapter 11 regardless of whether or not they emerge, thus avoiding survivorship bias.

Our sample of Chapter 11 bankrupt firms comes from several different sources. The most exhaustive source we use is a comprehensive list compiled by the Securities and Exchange Commission, which was kindly provided to us by Douglas Berman. Our sample also includes firms contained in Betker (1995) and Altman (1984). Finally we examined the *Wall Street Journal Index* for additional firms. From these sources, 393 firms satisfied our criteria for sample inclusion. We then verified the outcome of the bankruptcy process using Lexis - Nexis and the *Wall Street Journal Index*. We classified the outcome of the bankruptcy process as either plan confirmed and emerged, firm still in Chapter 11, or status changed to Chapter 7 under which the firm was liquidated. For firms for which we were unable to find a bankruptcy resolution date, we located phone numbers from *Wards Business Directory* and placed calls to these firms. We were able to verify the resolution of the bankruptcy process for an additional 20 firms in this manner.

We use data from the Longitudinal Research Database (LRD), located at the Center for Economic Studies at the Bureau of the Census. The LRD database contains detailed plant-level data on the value of shipments produced by each plant, investment broken down by equipment and buildings, and the number of employees. There are several advantages to this database in addition to detailed plant-level data. First, the database covers both public and private firms in manufacturing industries. This mix is especially advantageous when examining firms in bankruptcy. We can examine public firms which subsequently do not emerge from Chapter 11 or emerge as private firms. Second, coverage is at the plant level and output is assigned by plants at the 4 digit industry SIC code level. Thus, firms that produce in multiple SIC codes are not assigned to just one industry. Third, coverage at the plant level allows us to track plants even as they change owners. Fourth, the database

identifies when plants are closed and not merely changing ownership.¹⁶

The LRD covers approximately 50,000 manufacturing plants every year in the Annual Survey of Manufactures (ASM), the database we utilize. In the ASM, plants are covered with certainty if they have greater than 250 employees, and smaller plants are randomly selected every fifth year to complete a rotating 5 year panel. We confine our analysis to 1977 - 1990. We use 1977 as the starting year of our analysis because it is a complete Census year. Earlier name records for the firms in this panel are incomplete thus making it difficult to identify bankrupt firms in the early '70s. 1990 is the last year of data available at the time the analysis was undertaken.

We matched our sample of bankrupt firms to name records from the LRD. We were unable to match the names of several firms either because they were not manufacturing firms or because we were unable to find the name records for the firms in the LRD. Name records may not be able to be matched for several potential reasons. The bankrupt firm may be part of a larger corporation and the name records in the LRD are frequently at the division level, name changes at the firm level may not be updated in the LRD, or because of abbreviations in firm names that do not permit unique identification. Given that the remaining firms for which we were unable to find a resolution date were generally small firms that changed names, we used the Longitudinal Research Database (LRD) to locate subsequent name changes for these firms. Of the original 393 firms, 302 firms remained in our final sample of matched firms with verification that there was either a resolution of bankruptcy or that the firm remained in bankruptcy.

3.2 Variable Selection

We use both plant-level efficiency variables and industry-level variables in order to test our hypotheses that there are no bankruptcy costs and that value-maximizing transfers occur for bankrupt firms. We examine whether plant-level efficiency and asset sale and closure decisions are different than the decisions of industry competitors. The following section describes the variables used.

¹⁶A potential disadvantage of this database is that it does not have capital structure data. We have both private and public firms and thus cannot add this data as many of the firms are private, in addition to the extensive matching that would be required. However, we identify bankruptcy status and, thus, can test our null hypotheses of no bankruptcy costs and that transfers and closures are unaffected by bankruptcy status.

3.2.1 Productivity and Cash Flow Variables

We calculate both productivity and a simple measure of plant cash flow for the bankrupt and non-bankrupt industry firms. Operating cash flow is a simple measure of performance that is calculated as the value of shipments less labor, materials and energy costs divided by value of shipments. This measure is calculated at the plant- and firm-level, noting that at neither the plant- nor firm-level do we have corporate overhead or corporate selling, general and administration expense. The cash flow measure is thus an operating margin.

Our primary measure of performance is Total Factor Productivity (TFP). TFP compares the actual amount of output produced for a given amount of inputs with a predicted amount of output. Predicted output is what the plant should have produced given the amount of inputs it used. A plant that produces more than the predicted amount of output, given its actual inputs, has a greater than average productivity. This measure has the advantage over the simple cash flow measure in that it is much more flexible - and does not impose the restriction of constant returns to scale and constant elasticity of scale that a “dollar-in” - “dollar-out” cash flow measure imposes.

In calculating the predicted output of each plant we make an assumption about the functional form of the firm’s production function which defines the relationship between the plant’s inputs and outputs. We then obtain TFP as the residual from the estimation of a production function using all plants in the industry from 1977-1990.¹⁷

We assume that all the plants in our sample have a translog production function. This functional form is a second-degree approximation to any arbitrary production function and thus takes into account interactions between inputs.¹⁸ To estimate predicted outputs we take the translog production function and run a regression of log (total value of shipments) on log of inputs - including cross product and squared terms:

$$\ln Q_{it} = A_i + a_j \ln L_{jit} + \sum_{j=1}^N \sum_{k=j}^N a_{jk} \ln L_{jit} \ln L_{kit},$$

¹⁷Our approach follows Kovenock and Phillips (1995). Alternatively, predicted outputs for each plant can be calculated using averages of each of the inputs in the industry and the plant’s own inputs. However, the regression approach has the advantage that the calculated average TFP is zero for each industry. Thus, the TFP numbers we present describe the plant’s productivity relative to others in the industry. An additional advantage of our approach is that it does not impose constant returns to scale nor constant elasticity of substitution.

¹⁸The translog production function has been used by Kim and Maksimovic (1990) in a study of agency costs and airline productivity and by Caves and Barton (1991).

where Q_{it} represents output of plant i , in year t , the quantity $(j, k = 1, \dots, N)$, denotes the quantity of input j or k used in production for plant i for time period t . A_i is a technology shift parameter, assumed to be constant by industry, and $a_j = \sum_{i=1}^N a_{ji}$ indexes returns to scale. We standardize plant-level TFP by dividing by the standard deviation of TFP for each industry. Thus, our results are *not* driven by differences across industries in the dispersion of productivity in each industry.

In estimating the TFPs for plants in our sample we use data for over 500,000 plant years, and approximately 50,000 plants each year. Over 90 percent of the plants in the ASM in this period are in an industry in which a firm has filed for Chapter 11. As explanatory variables in the productivity regression for each industry we include three different types of inputs: capital, labor, and materials. All of these data exist at the plant level. However, the ASM does not contain the actual quantity shipped by each plant but rather the value of shipments. As a result, we take the difference between actual shipments and predicted shipments as our measure of TFP. Inflation adjustments to the data are made using 4 digit SIC code data from the Bartelsman and Gray (1994) database. Depreciation adjustments are made at the two digit level using data from the Bureau of Economic Analysis. These inputs and how we account for inflation and depreciation of capital stock are described in more detail in Kovenock and Phillips (1995).¹⁹

In addition to the productivity and cash flow variables at the plant level, we include other firm and plant-level variables to help control for unmeasured productivity differences and other factors such as size that may influence the asset sale and closure decision. We include the log of firm size, relative plant scale, plant age and the number of plants a firm operates. Firm size is the total value of shipments. The number of plants and size may influence the closure decision as firms may reallocate production to other plants if there is underutilized capacity. Plant scale is the plant's asset size divided by the average asset size for plants in each industry. Plant age is the earlier of 1972, the first year of the database, or the first year the plant appeared in the database.

3.2.2 Industry Variables: Shipments and Capacity Utilization

We focus on shipment or output growth and industry conditions for three reasons. First, we want to capture what is the value of capital and the value of transferring assets in an industry. Second, there may be an "option-like" effect. Firms may be less likely to close

¹⁹For a more detailed description of the the Longitudinal Research Database (LRD) see McGuckin and Pascoe (1988).

unproductive plants because variable demand makes it valuable for firms to remain in the industry. Third, there may be a cash constraint effect. If bankrupt firms in high growth industries are less cash constrained than those in low growth industries, then managers may not sell or close assets at the optimal time.

We calculate several different measures of industry demand and supply conditions. Our central variables are the yearly and long-run changes in industry shipments, industry-level research and development and capacity utilization. For industry shipments we use the Bartelsman and Gray (1994) database at the National Bureau of Economic Research (NBER) at the 3 digit SIC code level. We use industry shipments and investment data to investigate if long run changes in an industry affect the number of firms entering and leaving bankruptcy and the relative performance of these firms.

Industry research and development is calculated from COMPUSTAT firm-level data and represents research and development and advertising weighted by the firm's percentage of industry sales aggregated up to the 3 digit SIC code level. Industry research and development is included to capture how industries may differ by whether they may be creating specialized or unique products that are hard to value because of differences in quality and information.

Capacity utilization is obtained from the *The Annual Survey of Capacity Utilization*, a publication of The Bureau of the Census. The capacity utilization measure we use from this survey is output as a percentage of normal full production at the 3 digit SIC code level. Capacity utilization is included to capture changes in the supply relative to demand conditions and to examine whether excess capacity may exist in industries that could cause firms to optimally close down plants.

Our model suggests that the level of industry demand is important in determining the incentives of firms to transfer assets and of the gains to managers of acting opportunistically. To investigate whether these changes in incentives alter the relationship between the explanatory variables and actions (closures, asset sales) we divide our sample of industries into quartiles by level of demand. Where appropriate, we report results for both the entire sample and the quartiles.

Industries are classified into "demand" or change in shipment quartiles by constructing an index of long-run changes in real industry shipments over a 10 year period. We include all industries in constructing these quartiles - not just those which have firms entering bankruptcy. We measure the change by using the log of a three-year average of total shipments during the years 1986-1988 divided by the three year average from 1977-1979. We use total value of shipments - a production based number - for U.S. producers. Thus this measure will

also capture cost shifts from increased foreign imports or shocks to production costs, **as** well **as** demand changes in the industry. We use a three-year average as the endpoints to avoid short-term changes in demand. We classify all the three digit SIC industries in our database into quartiles based on our index of long-run changes in industry shipments. Three digit SIC industries are used to prevent smaller four digit industries from being overrepresented in any quartile. Next, we examine the productivity of the bankrupt firms' plants in these quartiles.

Note that by design we will *not* have a similar number of firms in each quartile. If certain industries have more firms and also more bankruptcies, the quartile containing these industries will have more firms represented. This enables us to examine whether industries with low growth have a higher frequency of bankruptcies and whether productivity of these firms is both significantly different from other firms in their quartile and from firms in other quartiles.

In addition to shipment growth quartiles, we also classify industries by annual changes in aggregate investment. We classify industries into quartiles by examining investment expressed in real 1982 dollars divided by total industry assets, again in real 1982 dollars. We use the Bartelsman and Gray data for investment and assets along with their constructed price deflators. Classifying industries in this fashion provides an aggregate industry-level measure of investment in an industry. These investment changes are a proxy for the marginal productivity of capital in an industry and the expectation of future returns in the industry. We then examine the relative number and productivity of plants for the bankrupt firms in each quartile. Again, there is no reason to expect a similar number of firms across quartiles. Using this procedure we examine whether bankrupt firms in industries with high investment have lower productivity than industry non-bankrupt firms and whether investment rates are lower than industry non-bankrupt firms. We also examine whether productivity decreases for firms while they are under Chapter 11 bankruptcy protection, for firms in each investment quartile. The results are similar using this classification and are available from the authors.

4. Results

4.1 Summary Statistics

Table 1 presents summary statistics for the firms and plants in our sample. Inspection of Table 1 reveals that in our sample the plants of bankrupt firms are on average bigger than those of non-bankrupt firms (average value of plant-level shipments of \$61.95m and \$29.76m respectively) and somewhat older (11.5 and 8.2 years respectively). In the whole sample,

the average standardized TFP of plants of firms that filed for bankruptcy, calculated the year prior to filing of Chapter 11, is -0.048. Thus, these plants do have a lower productivity than their industry averages. The difference across all industries and all shipment growth quartiles is statistically significant at the 10 percent level.

Table 1 also shows the median growth in real industry shipments for each industry quartile and the summary statistics of the frequency of Chapter 11 bankruptcies across quartiles. There is a large difference in the real growth of industry shipments between quartile one and quartile four. In quartile four shipments increase by 23.14 percent over the 10 year period, while in quartile one they decrease by 33.93 percent. There is also a large difference in the frequency of Chapter 11 across quartiles. The proportion of plants in Chapter 11 falls monotonically from 3.23% to 0.98% as we move from low growth industries to high growth industries, suggesting that the incidence of bankruptcy depends on industry demand.

Table 1 goes here

4.2 Industry Conditions and Bankruptcy

In this section we show how the efficiency of firms' plants and the numbers of plants entering and emerging from bankruptcy vary with industry growth. We test the first two of our predictions regarding the existence of bankruptcy costs from the theoretical model. First, in Table 2, we test whether the population of bankrupt firms differs across high and low growth industries. Second, in Table 3, we examine whether there are declines in productivity during bankruptcy and whether these declines are greater in the high growth industries.

Table 2 provides evidence on the relative productivity and cash flows of Chapter 11 plants before, during and after emergence from bankruptcy. This table includes plants of firms which do not emerge from Chapter 11 as well as those plants which eventually emerge, are sold off, closed or transferred to Chapter 7, for the years in which they are in Chapter 11. Thus, these initial data do not control for changes in the composition of firms over time as firms make partial firm asset sale and closure decisions.

Insert Table 2

Table 2 presents industry-adjusted productivity statistics by year - relative to the year the firm filed for Chapter 11, which we call year zero. In the interest of space, we present data only for the total sample and quartiles one and four.²⁰ The last column of the table

²⁰The largest differences in average plant productivities are between quartiles one and four. The results for quartiles two and three are available from the authors.

tests whether there is a significant difference between the productivities of plants in quartile one and quartile four.

Panel A reports average total factor productivity of plants of bankrupt firms relative to industry counterparts for the two years prior to filing for Chapter 11 protection. Panel B presents average industry-adjusted productivity for years while the firm is under Chapter 11 protection and Panel C, for the years after emerging from Chapter 11. These panels also report t-statistics for this average and for the unreported change in productivity relative to year prior to Chapter 11. The unreported changes can be calculated by subtracting the average productivity in the year prior to Chapter 11 from the productivity for the year in question.

Inspection of Panel A reveals that on average, across all quartiles, plants have significantly lower productivity than their industry counterparts. However, this significant negative productivity is concentrated in Quartile 4. The average productivity for the other quartiles in the year prior to Chapter 11 is not significantly different from their industry counterparts. Quartile one does have negative average productivity, however, this difference is insignificant.

In Panel B, we test for whether the average productivity is significantly different from zero and whether there are significant declines in productivity relative to year -1. For the full sample the average industry-adjusted productivity in year 0 is negative and significant. All other industry-adjusted levels are insignificant. However we find very different results when we subdivide by quartiles: In quartile one the average levels are positive, albeit insignificant, for four of the five years covered while the firm is under Chapter 11 bankruptcy protection. In quartile four, the average industry-adjusted productivity is negative, and significant, in four of the five years.

In the last column, we test for equality of means across quartiles and find significant differences between quartiles four and one. In 3 out of 5 years during Chapter 11, the average industry-adjusted productivity, reported in table 2 in quartile four are significantly different from quartile one. This initial evidence indicates that for firms in industries with low or negative demand growth, Chapter 11 does not seem to be associated with relatively inefficient operations. Secondly, these findings show that differences between industries are important in determining the relative productivity and cash flow while in Chapter 11.

We next test whether the average productivity of plants of firms in Chapter 11 changes during bankruptcy relative to the year prior to bankruptcy. The table only presents the t-statistic for this change in productivity, since the actual change can be computed using the level at time -1 and the reported level from that year. For the full sample and quartiles

one and four there is no evidence of significant changes in industry-adjusted productivity. Thus, we cannot reject the hypothesis that the plants of bankrupt firms do not decline in productivity in Chapter 11, either for the whole sample or for the quartiles separately.

However, this table only gives us the change in the average productivity for assets that *remain* associated with bankrupt firms and does not control for changing asset composition because of asset sales and closures. We revisit the question of whether plant productivity declines during Chapter 11 in Table 3, where we control for changing asset composition..

Panel C shows the productivity of the plants of firms which emerged from Chapter 11. Average productivity on emergence is negative and significant at the 10 percent level for the whole sample and for the low growth quartile. Only in the year of emergence do we find that industry-adjusted average productivity is significantly different from zero. In no years do we find that the change in industry productivity relative to the year prior to Chapter 11 is significantly different from zero. However number of plants the firm operates on emergence has declined sharply to **372** plants out of **1075** plants. Plant counts are low because of asset sales and closures in addition to the firm failing to emerge from Chapter 11. We directly examine asset sale decisions in Tables 4 6 and closure decisions in Tables 7-9.

We also examined cashflows of plants of Chapter 11 firms. The overall findings are consistent with Table 2, thus in the interest of space, we do not present these findings. We did find some interesting patterns when looking at average cash flow *unadjusted* for industry averages in the year prior to bankruptcy. Average cash flows of plants (**.212** in year t-1), that had negative industry-adjusted productivity in quartile four in year t-1 in Table 2, are significantly *higher* (t-statistic = **2.75**) than cash flows of plants of firms in quartile one (**.144** in year t-1) whose productivity is not lower than that of their industry. This finding tells us that industry effects are very important. Plants that are relatively very unproductive in growing industries have higher cash flows than plants of firms that not less productive than their industry average in declining industries.

Table 3 directly controls for the changing asset composition of firms' assets while they remain under Chapter 11 bankruptcy protection. The productivity in the year prior to Chapter 11 and the change in productivity relative to that year are presented. Each row of Table 3 follows the same set of plants over time, based on the number of years the plants are in Chapter 11. Thus, for example, in the two-year row, if plants are sold or closed prior to the end relative year **2**, or retained for more **3** years, we exclude those plants in this row.

Insert Table 3 here

Inspection of Table 3 reveals significant differences between quartiles one and four. In industries with the lowest output growth, there is no significant decline in industry-adjusted productivity in Chapter 11. Thus, there is no evidence of any costs of bankruptcy in the form of declines in productivity, in the low growth quartiles. There is evidence that plants in quartile one that exit within a year are on average less productive than their industry counterparts in year $t-1$ - but they do not suffer significant declines while in Chapter 11. In quartile four the productivity of bankrupt firms' plants shows a different pattern. After controlling for composition changes, the productivity of firms' plants that remain in Chapter 11 for four or more years significantly declines for years -1 to $+2$, -1 to $+3$ and -1 to $+4$. These declines are also significantly different from the productivity changes in quartile one.

The results in tables 2 and 3 do not allow any conclusions about whether or not bankrupt firms in the highest quartile should be making different economic decisions. However, we can conclude that in high output growth industries, bankrupt firms' plant-level productivity significantly declines when they remain in Chapter 11 four or more years. The evidence is consistent with a different population of bankrupt firms based on industry growth and a potential cost of Chapter 11 bankruptcy - the failure to transfer or close low-productivity assets. In the next section we examine whether the outcomes (asset sales and closures) vary depending on industry conditions.

4.3 Chapter 11 Outcomes: Asset Sales and Plant Closures

In this section we examine asset sale and closure decisions of Chapter 11 and industry firms. We present average productivities for plants sold, closed and retained, and estimate logistic regressions to evaluate the effects of industry-, firm- and plant-level variables on the probability of asset sales and closures. The logistic regressions enable us to test whether, conditional on these variables, bankrupt firms' asset sale and closure decisions are similar to those of industry firms and sensitive to the same set of variables.

4.3.1 Asset Sales

This section examines asset sales for bankrupt firms for before, during and after Chapter 11. The plant-level focus of the database allows us to examine the productivity of the individual plants under new ownership. We also test for whether the productivity of the firms' remaining assets is on average lower because the firm has sold off its more productive assets. Our theoretical model makes three predictions about asset sales. First, relatively more asset sales will occur in high growth industries. Second, if there are increased conflicts of interest in bankruptcy, the frequency of asset sales will be reduced in these industries.

Third, for those asset sales by bankrupt firms which do occur, the increase in the productivity of assets sold will be greater under new ownership in high-growth industries.

Table 4A presents the results of a simple regression for bankrupt and non-bankrupt plants. We regress the change in the productivity of the sold plant on plant-, firm- and industry-level variables. Three indicators for the bankrupt status of the firm are included. The variables BEFORE, DURING, AFTER equal one for the years prior to, during, and after emerging from Chapter 11, respectively. We interact the during-bankruptcy indicator variable with lagged plant cash flow and the industry-level variables. These during-bankruptcy interactions are indicated with a D_ prefix.

Table 4A
Productivity of Asset Sales

Firm-level variables include log of firm shipments, FSHIP, and the number of plants for the firm, FPLANTS. Industry-level variables include the change in industry shipments, ISHIP, the standard deviation of industry shipments, DSD, industry-level research and development, RD, and industry-level capacity utilization, CAPUTIL. Lagged plant-level variables include relative scale, plant size divided by average industry plant size, SCALE, plant age, AGE, and cash flows divided by sales, CASHF. We include three indicators for the bankrupt status of the firm: BEFORE, DURING, AFTER equal one for the years prior to, during, and after emerging from Chapter 11, respectively. We interact the during bankruptcy indicator variable with lagged plant cash flow and the industry-level variables. The during bankruptcy interactions are indicated using a D prefix. We also include unreported year dummy variables. (p-values are in parentheses. n = 5109, $R^2=.052$)

$$\begin{aligned} \Delta TFP_t = & .117 + .872***\Delta ISHIP_t - .001 AGE_{t-1} + .009 FSHIP_t + .000 FPLANTS_{t-1} \\ & (.490) \quad (.0001) \quad (.492) \quad (.312) \quad (.968) \\ & + .003 SCALE_{t-1} - .757 DSD_t + .594 RD_t + .001 CAPUTIL_t - .762***CASHF_{t-1} \\ & (.646) \quad (.067*) \quad (.204) \quad (.672) \quad (.001) \\ & + .047 BEFORE - .677 DURING - .001 AFTER - 2.17 D_ISHIP_t + 6.56 D_RD_t \\ & (.428) \quad (.426) \quad (.994) \quad (.225) \quad (.334) \\ & + .002 D_CAP_t + 1.62***D_CASHF_{t-1} \\ & (.852) \quad (.006) \end{aligned}$$

***, **, * = significant at the 1, 5, 10-percent level, respectively, using a two-tailed t-test.

The results in this table support the model's prediction that the greatest increase in productivity following asset transfers occurs when industry shipments are high. Thus, the economic cost of imperfections that impede timely asset transfers is likely to be greatest in high growth industries. Lagged plant-level cash flow is negatively associated with the gain in productivity. Plants with low cash flow do experience productivity gains upon sale. Other plant- and industry-level variables are not significantly related to increases in productivity.

In particular, there is no evidence that, conditional on a sale occurring, asset specificity, as measured by industry research and development, affects the gains under new ownership.

We find only limited evidence that bankruptcy status affects the productivity gain of sold plants. We do find that the during Chapter 11 dummy variable interacted with plant-level cash flows has a positive effect on the change in productivity of plants sold. This finding suggests that asset sales of bankrupt firms with relatively higher cash flows than their industry counterparts are more likely to increase in productivity. There is no evidence of a delay in asset sales by bankrupt firms - a specific type of bankruptcy cost that was one of the predictions from our model.

Table 4B shows the productivity of sold and retained plants for bankrupt and industry firms' plants by quartile. The results are presented in four panels. Panels A, B, and C examine the assets sold off by Chapter 11 firms and their industry counterparts, before, during and after Chapter 11 respectively. We get a matching set of industry asset sales for each of these periods by getting all assets sales for the 4 digit SIC code of the bankrupt firm. We assign these industry asset sales to the before, during, and after Chapter 11 periods based on the status of the bankrupt firm in that industry. Lastly, panel D examines the productivity of the plants of industry purchasers, not including the plants that they purchase.

Insert Table 4B here

Inspection of Table 4B reveals several findings. First, more asset sales occur by Chapter 11 firms in high growth industries. Panel A shows that prior to Chapter 11, conditional on selling a plant, bankrupt firms sell 52.4% of their plants in the high growth quartiles versus 41.3% in low growth quartiles. Panel B shows that during Chapter 11, bankrupt firms sell 58.75% of their plants versus 44.37% in the bottom two quartiles. Both these proportions are higher than their industry counterparts.

Second, Panel B shows that the productivity of plants sold only improves in the two high growth industry quartiles. In Chapter 11, the productivity of the 47 plants sold in quartiles 3 and 4 significantly increases under the new owners. In Panel A and B, we also examine the plants retained by the firms and not subsequently sold off, finding that the plants retained in high growth industries are of lower productivity than the ones sold off-while for industry firms, plants retained are of significantly higher productivity than those sold.²¹ The last finding of this table, in Panel D, is that purchasing firms' existing plants

²¹The productivity of plants sold off after Chapter 11 are not presented as there were few partial firm

are more productive than the industry average - both before and after the purchase. This finding does not differ much by quartiles.

These results show the importance of changes to industry output to the asset sale process for all firms. More asset sales occur in high output growth industries. Second, bankrupt firms sell their relatively more productive plants in high growth industries and these plants improve in productivity under their new owners. The evidence is consistent with the prediction of the model that there is higher value of asset reallocations in high growth industries. The finding of increased productivity under new owners is consistent with a cost of bankruptcy - if these transactions, occurring earlier, would have produced gains. We investigate the asset sale process further by examining whether the probability of selling a plant, conditional on industry and productivity variables, is different for bankrupt and non-bankrupt firms.

Table 5 presents logistic results examining the probability of selling plants. The regressions include industry-level variables, along with plant- and firm-level variables and interact several of these variables with indicators of bankruptcy status. We run regressions for the full sample and for quartiles one and four of our long-run, 10-year change in industry shipments. The last column also presents a test of whether coefficients are significantly different between quartiles one and four. We test for differences by running a regression for all quartile one and four firms with a quartile four dummy variable interacted with the independent variables. We present the p-value for these interaction variables in the last column.

Insert Table 5 here

Table 5 shows that there are only limited differences between Chapter 11 and industry firms. For all firms, bankrupt and non-bankrupt, the industry variables – change in industry shipments, capacity utilization, industry R&D and the standard deviation of industry shipments are highly significant at the less than the one percent level. These results, in conjunction with Table 4A, show that growth in industry output positively affects both the frequency of asset sales and the productivity gain from asset sales, results consistent with our model. This suggests that the lower frequency of assets sales by bankrupt firms in low growth industries is not caused by imperfections that cause constrained firms to sell assets. The significance of the coefficients on our cash flow variable supports this conjecture. Plant-level cash flows are highly significant and positively related to the probability of selling a plant.

asset sales in quartiles 3 and 4 - preventing these numbers from being disclosed under government disclosure restrictions.

The results in Table 5 also show that asset sales are more frequent in industries with high research and development. This suggests that increased asymmetry of information in these industries does not impede the efficient transfer of assets. This is consistent with the finding in Table 4A that the level of research and development in the industry does not predict the change in productivity of sold plants.

There are some limited differences between the Chapter 11 bankrupt and industry firms. The coefficient on the dummy variable for the years before Chapter 11 is positive and highly significant. Chapter 11 firms are selling more assets before they enter Chapter 11. However, the dummy variables for the during and after Chapter 11 periods are insignificant. This finding shows that while in and after emerging from Chapter 11, bankrupt firms make asset sale decisions that are, on average, similar to their industries.

We also investigate whether asset sales of bankrupt firms are more sensitive to industry and productivity variables. We interact the before Chapter 11 and the during-bankruptcy dummy variables with total factor productivity, industry research and development, change in shipments and capacity utilization. There were no significant interactions between the before bankrupt-firm dummy and our independent variables. For the full sample of bankrupt firms there were also no significant interactions between the during-bankrupt firm dummy and the independent variables.

We do find differences in the during-bankruptcy interaction variables when we split our sample by quartiles. In quartile one, plants of Chapter 11 firms in industries with high research and development are more likely to be sold, while in quartile four they are *less* likely to be sold. These results are consistent with the population of firms in quartiles one and four being different. For all firms in quartile four, high research and development in the industry is associated with increased asset sales. By contrast, for bankrupt firms the rate is lower. This suggests that failed research and development and not asymmetric information is responsible for lower rates of asset sales by bankrupt firms in this quartile.

Other significant interactions also exist in quartile four. In quartile four, plants that are more productive and are in industries experiencing greater growth are more likely to be sold. This is consistent with our findings in Table 4B.²² We also find a significant negative interaction between firm-level cash flow and during bankruptcy dummy variable. These findings are also consistent with the bankrupt firm in the high growth quartile selling off its more efficient plants to raise cash.

²²Recall that industries are classified into quartiles by growth over the whole sample period, whereas the change in industry shipments is calculated annually.

The last column of this table reports p-values for tests of the equality of coefficients between quartiles four and one. The firm and plant specific productivity variables have a similar effect in high and low growth quartiles for both bankrupt and nonbankrupt firms. The only two firm specific variable that have a differential effect by quartiles are the number of plants a firm operates and plant age. It is mainly the industry variables, including the industry variables interacted with the in Chapter 11 dummy variable, that have significantly different effects in the high and low growth quartiles.

Insert Table 6 here

In Table 6 the economic significance of our results is presented by calculating the estimated probabilities of assets sales by bankrupt and non-bankrupt firms. The probabilities are computed at the means of all variables for the bankrupt sample and at the means of the non-bankrupt sample variables.²³ TFP is then varied from the 10th to the 90th percentile to examine how productivity differences affect the probability of asset sales for both of these samples of plants. Panel A illustrates that transition into bankruptcy does not have an economic important effect on the probability of asset sales. The probability of asset sales is similar in bankrupt year $t+1$ and in year $t-1$. Bankrupt firms do have a higher probability of selling assets, but this increased probability is driven by the differences in the mean values of our explanatory productivity, firm-level cash flows and industry variables for bankrupt and nonbankrupt firms. Evaluating the probability of asset sales by bankrupt firms at the mean of the data of the non-bankrupt sample, we find a **3-4** percentage points lower probability of asset sale. Evaluating the non-bankrupt firm's probability of sale at the mean of the bankrupt sample, there is a **2-2.5** percentage 'points increase in the probability of an asset sale. Thus, approximately two-thirds of the increased probability of sales by bankrupt firms is accounted for by differences in the sample means and one third by the before bankruptcy and during bankruptcy dummy variables. The during-bankruptcy interaction variables do not contribute significantly to the results.

The one case where there is an economically important difference for asset sales in bankruptcy is in quartile four. When we examine the probability of an asset sale by quartiles in Panel B, we find that for quartile four firms the probability of an asset sale in the year

²³When calculating the probability of an asset sale for the same subsample of data, the only difference between bankrupt and nonbankrupt firms' probability in year $t-1$ will be the effect of the bankrupt firm dummy. In year $t+1$ for the bankrupt firm, we add the during bankruptcy variable and its interactions. This procedure thus controls for differential data such as productivity differences.

subsequent to bankruptcy, increases with TFP. This is consistent with our earlier finding that quartile four firms sell their better assets in bankruptcy.

The results support our model's predictions about there being a higher value of reallocation for all firms, bankrupt and non-bankrupt, in high growth industries. We find no evidence of a lower rate of asset transfers for bankrupt firms. Thus the third prediction of our model, that a cost of bankruptcy in high growth industries is the failure to sell assets to more efficient firms is not supported. More asset sales do occur for bankrupt firms and the industry and plant productivity variables are highly significant in explaining these asset sales.

4.3.2 Plant Closures and Liquidations

In this section we consider plant closures by and liquidations of bankrupt firms. We first present average productivity numbers for closed plants and frequencies of closures for both bankrupt and industry firms. Next we examine whether the industry-, firm- and plant-level factors are associated with the decision to close a plant. We examine if there is any delay in closing plants by bankrupt firms - a potential bankruptcy cost that is predicted by our model if conflicts of interest are higher in bankruptcy.

Insert Table 7 here

Table 7 reveals that proportionally fewer closures occur in high shipment growth quartile four than in low growth quartile one industries. The plants closed in high growth industries are of significantly lower productivity than those closed in low growth industries. These findings show that relatively more unproductive plants remain open in the high growth industries, consistent with the finding in Table 2 of declining productivity in the high growth quartile four. This may occur because the plant may earn enough profits to cover variable costs. It may also be in a plant owner's interest not to sell or close an unproductive plant in a high growth industry because of the possibility of future productivity increases. Non-pecuniary benefits of control may also decrease the incentives to transfer or close assets. We next investigate whether industry characteristics can explain the probability of plant closure using logistic regressions.

The regressions include industry-level variables along with plant- and firm-level variables and interactions of several of these variables with indicators of bankruptcy status. We present logistic results for the full sample and for quartiles one and four. As in table 5, the last column presents a test of whether coefficients are significantly different between quartiles one and four. We test for differences by running a regression for all quartile one and four

firms with a quartile four dummy variable interacted with the independent variables. We present the p-value for this interaction variable in the last column.

Insert Table 8 here

Overall, we do not find evidence of costs of bankruptcy in the form of delay or failure to close plants. The logistic regressions show that for all firms the industry-level variables, change in industry shipments and weighted industry research and development, are highly significant at the less than the one percent level. We find that the probability of closure is negatively related to the change in industry shipments. Plant-level cash flows and productivity are also significantly negatively related to closures. Both results are consistent with economic efficiency.

While there are some differences between firms that experience bankruptcy and non-bankrupt firms, we find limited evidence that being in Chapter 11 affects closing decisions. After controlling for other variables, firms that declare bankruptcy have increased rates of closures before Chapter 11 and after Chapter 11 but not during Chapter 11. The coefficient on the dummy variables for before and after Chapter 11 are positive and highly significant. However, the variable indicating that the firm is in Chapter 11 is not significant.

We interacted the before, during, and after Chapter 11 bankrupt-firm dummy variables with total factor productivity, cash flow, industry research and development, change in shipments and capacity utilization. There were no significant interactions between the before and after Chapter 11 bankrupt-firm dummy variables and the industry variables. We do not report these interactions.

There were significant interactions between the during Chapter 11 dummy variable and our independent variables. While in Chapter 11, firms' closing decisions were more sensitive to the change in industry shipments and the level of industry research and development. The interaction with the change in industry shipments is negative and significant, showing that a decline in shipments causes the probability of closure to increase. The increased sensitivity to industry shipments suggests that the bankrupt firms' plants are marginal plants in the industry. The negative association between the interaction of bankruptcy and industry research and development shows that firms are closing more in industries with low research and development. This finding is consistent with there being fewer perceived growth options in these industries.

Except for the case of quartile four firms, we find no evidence that the productivity of plants closed by bankrupt firms differs from that of plants closed by other industry firms.

In quartile four, there is a negative interaction, significant at the 10 percent level, between total factor productivity and the in-bankruptcy variable. Thus, as productivity increases these plants are less likely to be closed. No significant interactions exist between cash flow and the in-bankruptcy variable. This indicates that cash flows do not differentially effect closure decisions of bankrupt firms.

The last column of this tables tests whether coefficients are significantly different between quartiles four and one. We report pvalues for this test in the last column of this table. The significant differences between these quartiles are in the effect of the industry and productivity variables for all firms. For bankrupt firms, we find significant differences between quartiles one and four in the effect of the industry research and development. In high growth quartiles, increased industry research and development is associated with a lower probability of closing a plant.

Insert Table 9 here

In Table 9 we investigate the economic significance of our results. As in the case of asset sales, we compute the estimated probabilities of plant closures at the means of all variables for the bankrupt sample and at the means of the non-bankrupt sample. In this table, we examine how the change in industry shipments affects the probability of closure for the bankrupt and non-bankrupt samples. We find that the probability of closure is higher for bankrupt firms. At the 50th percentile, the probability of closing the year prior to bankruptcy is 3.11 percent for bankrupt firms and **1.64** percent for non-bankrupt firms, both evaluated at the mean of the variables of the bankrupt firm sample. The increased probability is related to the higher sensitivity of bankrupt firms' closure decisions to the industry variables interacted with the during-bankruptcy dummy variable. We also find a striking difference between quartile one and quartile four. At the means of these quartiles, the probability of closing is 9.1 percent for quartile one and only 0.38 percent for quartile four. These results show that average closure rates are significantly higher and economically important for bankrupt firms in the low growth quartile. In declining industries, Chapter 11 appears to be a mechanism for fostering the exit of capacity.

The final piece of evidence examines firms that convert to Chapter 7 from Chapter 11. In Chapter 7 the firm does not emerge but either sells or closes all its plants. All the prior tables did include these Chapter 7 firms while they were in Chapter 11 - thus avoiding survivorship bias. We remove the firms which subsequently file for Chapter 7 firms from the full Chapter

11 set in this table. Thus this table compares firms selected for Chapter 7 liquidation with those that emerged or remain in Chapter 11. In Panel C, columns 1 and 3 represent the years after Chapter 11 for firms emerging from bankruptcy. Columns 2 and 4 represent the years in Chapter 7 after transferring from Chapter 11 for the bottom 2 and top 2 quartiles, respectively. We assign firms to Chapter 7 based on the year end status, thus some firms transfer to Chapter 7 within the same year of declaring Chapter 11. Year 0 is not included in this panel because in this year firms spend part of the year in Chapter 11 and part of the year in Chapter 7.

Insert Table 10 here

Inspection of Panel C in Table 10 shows that the productivity of plants while in Chapter 7 is much lower than the productivity of plants of firms that emerge from Chapter 11. The productivity of these plants of Chapter 7 firms is also much lower than the productivity of plants while firms are in Chapter 11, shown in Panel B. There are also more Chapter 7 liquidations in the lowest two shipment growth quartiles. The lower productivity of Chapter 7 plants shows that, consistent with economic efficiency, plants selected for liquidation are indeed significantly less productive. Both plants selected for Chapter 7 liquidation *and* closed plants (presented in Table 7), that are closed *outside* of Chapter 7 have significantly negative productivity, suggesting Chapter 11 process does discriminate between inefficient and efficient firms. Overall, the higher incidence of Chapter 7 liquidations, combined with higher incidence of closures and Chapter 11 bankruptcies in low industry growth quartiles, again emphasizes the importance of industry effects to the selection into Chapter 11 and Chapter 7.

5. Conclusions

In this paper we have investigated how industry shipments and other industry characteristics affect firms' performance in bankruptcy and the decision to redeploy assets. We do not find much evidence of real bankruptcy costs. Chapter 11 bankruptcy status is relatively less important than industry and plant-level productivity factors in influencing bankrupt firms' decisions. Bankrupt firms do have a higher probability of closing plants in declining industries. This higher probability results from an increased sensitivity of closure to industry shipments.

Our model and evidence show that incentives to sell and close plants depend on industry demand and capacity utilization which determine opportunity costs of assets. Firms may

enter bankruptcy, sell and/or close plants because the number of plants that can operate profitably in the industry may change and not because of relative firm inefficiency. Under plausible assumptions, the value of reorganizing is highest when industry growth is highest. However, at this time the likelihood of bankruptcy may be lowest because the overall level of industry cash flows is high. Our empirical results show that the frequency of bankruptcy is indeed lowest in high growth industries. This suggests that bankruptcy may not be a mechanism used to screen out inefficient firms in these industries.

Most bankruptcies are likely to occur precisely when the opportunity costs of assets are low. The efficient resolution of bankruptcy may involve the sale of some assets, closure of other assets and the survival of some less productive assets, whose value derives from an option on the level of industry demand. As a result, the evaluation of the bankruptcy process must track all of these outcomes and cannot focus only on the productivity of survivor firms.

Our empirical results support our model of asset transfers. They show that for all firms, sales are more likely when industry growth is high and that these sold assets increase in productivity under new ownership. Our findings also show that frequencies of bankruptcies, asset transfers, and plant closures are systematically related to growth in industry shipments. We find that there are more than three times the proportion of plants that are in Chapter 11 in low growth industries as in high growth industries. However, productivity of plants in low or negative growth industries is *not* significantly different from their industry counterparts. Thus we find no evidence of any bankruptcy costs in these industries. For firms in industries with low or negative demand growth, Chapter 11 protection does not seem to be used by low productivity firms so that they can avoid closing or selling inefficient plants.

The results are different for plants belonging to firms that declare Chapter 11 in industries where shipment growth is in the highest quartile. Although these plants are a lower proportion of plants in their industries, their average productivity is significantly lower than that of their industry counterparts. After correcting for survivorship bias because of plant sales and closures, the productivity of plants of bankrupt firms in high growth industries, while low, only decreases over time for firms that remain in Chapter 11 for four or more years. These findings show that asset composition and survivorship bias is a serious problem that must be accounted for before making any comparisons between ex-post and ex-ante performance. Bankrupt firms' performance measures change for the most part because of asset sales and closures and not because of any change in the efficiency of retained assets.

When we analyze the redeployment of plants of Chapter 11 firms several conclusions emerge. First, in high growth industries the productivity of purchased plants increases under

new ownership whereas in declining industries it does not. This finding is consistent with the conclusion of our model that the value of asset transfers increases in high growth industries. Second, the purchasers of bankrupt firms' plants are more efficient than the average firm in their industry.

Our logistic regressions show that industry-level research and development is significant in explaining the asset sale and closing decisions. In industries with high research and development and high growth in shipments, firms in bankruptcy are less likely to close and sell plants. These results suggest that asset specificity and technological change may affect the value of assets and whether assets are sold.

The logistic regressions also show that for all firms, bankrupt and non-bankrupt, the probability of closure is negatively related and the probability of asset sales is positively related to the change in industry output. Bankruptcy status has a minimal effect on the probability of selling a plant. The probability of closures is higher for bankrupt firms in declining industries. This higher probability arises from the increased sensitivity of closures to changes in industry shipments during Chapter 11.

The model and results suggest that in industries where the opportunity costs of assets are high and positively correlated with cash flows, mechanisms other than bankruptcy may have a more important role in restructuring inefficient firms. In future research we will examine these factors and whether financial distress and the threat of bankruptcy affects the asset redeployment process under different demand conditions.

Appendix

Proof of Proposition 1

Let the optimal number of capacity units operated by firms of high and low quality firms be k^h and k^l respectively. The output of high quality firms is obtained by maximizing the firm's operating profit, $pk^h - rk^h - w(k^h)^2$. Solving for k^h , we obtain $\frac{p-r}{2w}$ as the optimal capacity that high quality firms operate at the given opportunity cost r . The capacity at which the low quality firms operate is similarly obtained as $k^l = \frac{p^d-r}{2w}$. Notice that $k^h > k^l$, so that a high quality firm uses more capacity than the bad firm at every price level.

Assume first that no firm exits at time t_0 . The market price of the output is $p = a - b\pi(\pi k^h + (1-\pi)k^l)$. The rental price of capacity is determined by equating the demand for capacity by each type of firm to the total number of capacity units available, either on

the secondary market or supplied by manufacturers, so that

$$K + \alpha + br = \pi n \frac{p - r}{2w} + (1 - \pi)n \frac{pd - r}{2w}. \quad (1)$$

The first term on the right hand side of the equation is the demand for capacity by the $n \times n$ good firms and the second term is the demand for capacity by the $(1 - \pi)n$ bad firms. Solving equation (1) for the opportunity cost of capacity yields

$$r = \frac{p(\pi + d(1 - \pi))n}{n + 2\beta w} - \frac{2w(K + \alpha)}{n + 2\beta w}. \quad (2)$$

We first characterize the values of a for which both h and l firms produce in the first period and $r > s$. Substituting the expression for the rental cost of capital (2) into the expressions for the desired capacity by high and low quality firms, we obtain

$$k^h = \frac{K + \alpha}{n + \beta w} - \frac{(1 - d)(1 - \pi) + 2\beta w}{2w(n + \beta w)}p \text{ and } k^l = \frac{K + \alpha}{n + \beta w} - \frac{(1 - d)\pi - 2\beta dw}{2w(n + \beta w)}p. \quad (3)$$

For $d < \frac{n\pi}{n\pi + 2\beta w}$, as p increases, k^h increases and k^l decreases. The low quality firms are at their minimum size of one unit of capacity for $p^* = (r + 2w)/d$. The rental price of capital r^* can be obtained from

$$K + \alpha + \beta r^* = \pi n \frac{p^* - r^*}{2w} + (1 - \pi)n.$$

Solving the last two relationships yields

$$p^* = \frac{2w((K - n) - (2\beta w - a))}{(1 - d)n\pi - 2\beta dw}$$

Substituting in the expression for p^* in the demand equation yields the level of demand at which low quality firms produce at minimum efficient scale.

$$a' = p^* - b(K + a + \beta r^* - (1 - d)(1 - \pi)n).$$

As a increases above a^* , low quality firms have an incentive to sell their remaining unit of capacity to high quality firms and to leave the industry. However, in equilibrium all the low quality firms cannot leave the industry at $a = a^*$ for $\pi < 1$. If this were to happen at a^* there would be a discontinuous increase in production as $1 - \pi$ units of capacity are transferred to high quality firms. This increase in production drives the price below p^* , making it suboptimal for low quality firms to leave the industry. Thus, low quality firms

leave the industry over an interval at a rate that leaves the remaining low quality firms indifferent between leaving and continuing to produce at the minimum efficient scale.

We next characterize the value of a , a^{**} at which the last remaining low quality firm exits. At a^{**} the market price of output is $p^{**} = a^{**} - b(K + a + \beta r^{**})$ and the rental price of capital is given implicitly by $r^{**} = p^{**} - 2w(K + a + \beta r^{**})/(n\pi)$. Solving explicitly for the rental cost of each unit of capacity and the price of the final output, we obtain

$$r^{**} = \frac{n\pi(a - b(K + a)) - 2w(K + a)}{n\pi(1 + b\beta) + 2pw},$$

and

$$p^{**} = \frac{n\pi(a - b(K + a)) - 2wa\beta}{n\pi(1 + b\beta) + 2\beta w}$$

The last low quality firm exits the industry when r^{**} equals the proceeds from operating the capacity $dp^{**} - w$. Equating the two and solving, yields a^{**} . In the region between these two limits the low quality firms adopt mixed strategies. Some sell all their capacity and leave the industry at t_0 , whereas others remain in the industry at the minimum efficient scale. To characterize the equilibrium in this region, let x be the proportion of low quality firms that remain in the industry at time t_0 . These firms each control one unit of capacity. The price of output is equal to $p_x = a - bK + a + \beta r_x + bd(1 - \pi)xn$. The price of capacity is obtained by solving

$$r_x = p_x - \frac{2w(K + a + \beta r_x - (1 - \pi)nx)}{n\pi}$$

Explicit values for p_x and r , can be derived by solving the last two equations. The relationship between a and x can then be obtained from the marginal equilibrium condition $r_x = dp_x - w$. As a increases fewer lower productivity firms remain in the industry.

Next consider the value of a for which r , given in equation (2) equals s . For this and lower levels of a the opportunity cost of capacity is s and no new capacity enters the industry. Thus, the desired capacity of high and low quality firms is given by equations (3) with $\alpha = \beta = 0$. As a declines in this region the capacity operated by both high and low quality firms also declines and capacity leaves the industry. Low-capacity firms shrink to their minimum efficient scale at a value a' . As above, in some interval $[a'', a']$ some low quality firms remain in the industry while others close down. At a'' all the low quality firms are closed. Similarly, there exists an interval $[a^{hh}, a^h]$, where $a^h < a''$, in which the high quality firms leave the industry.

References

- [1] Altman, Edward, 1984, A Further Investigation of the bankruptcy cost question, *Journal of Finance*, 39, 1067-1089.
- [2] —, 1993, *Corporate Financial Distress and Bankruptcy*, New York: John Wiley.
- [3] Andrade, Gregor and Steven N. Kaplan, 1996, How Costly is Financial (not Economic) Distress? Evidence from Highly Leveraged Transactions that Became Distressed, University of Chicago working paper.
- [4] Aghion, P. and P. Bolton, 1992, An Incomplete contracts approach to financial contracting, *Review of Economic Studies*, 59, 473-94.
- [5] Bartelsman, E.J. and W. Gray, 1994, The NBER Manufacturing Productivity Database.
- [6] Bergman, Yaacov Z., and Jeffrey L. Callen, 1991, Opportunistic underinvestment in debt renegotiation and capital structure, *Journal of Financial Economics*, 29 137-171.
- [7] Betker, Brian L., April 1995, "Management's Incentives, Equity's Bargaining Power and Deviations from Absolute Priority in Chapter 11 Bankruptcies," *Journal of Business*, 68, 161-184.
- [8] Bolton, P. and D.S. Scharfstein, 1993, Optimal Debt Structure with Multiple Creditors, LSE Capital Markets Group Discussion Paper No. 161.
- [9] Brennan, M.J. and E.S. Schwartz, 1985, Evaluating Natural Resource Investments, *Journal of Business*, 58, 135-57.
- [10] Brock, W.A. and D.S. Evans, 1986, *The Economics of Small Business: Their Role and Regulation in the U.S. Economy*, New York: Holmes and Meier.
- [11] Brown, D., C. James, and R. Mooridian, 1993, The Information Content of Distressed Restructurings Involving Public and Private Debt Claims, *Journal of Financial Economics*, 33, 93-118.
- [12] Bulow, Jeremy I. and John B. Shoven, 1978, The Bankruptcy Decision, *Bell Journal of Economics*, 9, 437-456.
- [13] Cabellero, R., E. Engel, and J. Haltiwanger, 1995, "Plant Level Adjustment and Aggregate Investment Dynamics," working paper, University of Maryland.

- [14] Caves, Richard E. and David R. Barton, 1991, Efficiency in U.S. Manufacturing. MIT Press, Cambridge, MA.
- [15] Chevalier, J., 1995, Debt and product market competition: Local market entry, exit, and expansion decisions of supermarket chains. *American Economic Review*, 85, 415-35.
- [16] Diamond, D. W., 1993, Seniority and Maturity of Debt Contracts, *Journal of Financial Economics*, 33(3) 341-68.
- [17] Franks, J., and W. Torous, 1989, An Empirical Investigation of U.S. Firms in Reorganization, *Journal of Finance*, 44, 747-769.
- [18] Gertner R., and D. Scharfstein, 1991, A Theory of Workouts and the Effects of Reorganization Law, *Journal of Finance*, 46, 1189-1222.
- [19] Giammarino, R., 1989, The Resolution of Financial Distress, *Review of Financial Studies*, 2(1), 25-47.
- [20] Gilson, S., 1990, Bankruptcy, Boards, Banks and Blockholders: Evidence on Changes in Corporate Ownership and Control When Firms Default, *Journal of Financial Economics*, 27, 355-87.
- [21] Gilson, S., John, K., and Lang, L., 1990, Troubled Debt Restructurings: An Empirical Study of Private Reorganization of Firms in Default, *Journal of Financial Economics*, 26, 315-53.
- [22] Harris, M. and A. Raviv, 1990, Capital Structure and the Informational Role of Debt, *Journal of Finance*, 45 321-349.
- [23] Hart, O. and J. Moore, 1995, Debt and Seniority: An Analysis of Hard Claims in Constraining Management, *American Economic Review*, 85, 567-87.
- [24] Haugen, R.A. and L.W. Senbet, 1978, The Insignificance of Bankruptcy Costs to the Theory of Optimal Capital Structure, *Journal of Finance*, 33 383-93.
- [25] Hotchkiss, E. S. 1995, Post-Bankruptcy Performance and Management Turnover, *Journal of Finance*, 50, 3-21.
- [26] Jensen, M. C. 1993, The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems, *Journal of Finance*, 48(3), 831-80.
- [27] John, K. and G. Vasudevan, 1994, Bankruptcy and Reorganization: A Theory of the Choice Between Workouts and Chapter 11, NYU working paper.

- [28] Khanna, N. and A. Poulsen, 1995, Managers of Financially Distressed Firms: Villains or Scapegoats?" *Journal of Finance*, 50(3), July 1995, 919-40.
- [29] Kovenock, Dan and Gordon Phillips, 1995, Capital Structure and Product Market Behavior: An Examination of Plant Exit and Investment Behavior., Center for Economic Studies working paper, #95-4.
- [30] Lang, L. and R. Stulz, 1992, Contagion and Competitive Intra-industry Effects of Bankruptcy Announcements: An Empirical Analysis, *Journal of Financial Economics*, 32, 45-60.
- [31] Lichtenberg, F. and D. Siegel, 1990, The effect of LBOs on Productivity and Related Aspects of Firm Behavior, *Journal of Financial Economics*, 27, 165-94.
- [32] Lucas, R., 1978, On the Size Distribution of Business Firms, *Bell Journal of Economics*, 9, 508-23.
- [33] McGuckin, R. H. and G. Pascoe, 1988, The longitudinal research database: status and research possibilities, *Survey of Current Business*.
- [34] Maksimovic, V. and J. Zechner, 1991, Debt, Agency Costs, and Industry Equilibrium, *Journal of Finance*, 46, 1619-43.
- [35] Morck, R., Shleifer, A. and R.W. Vishny, 1989, Alternative Mechanisms for Corporate Control, *American Economic Review*, 79, 842-52.
- [36] Rajan, R., 1992, Insiders and Outsiders: The Choice Between Relationship and Arms-Length Debt, *Journal of Finance*, 47, 1367-1400.
- [37] Shleifer, A. and R. W. Vishny, 1992, Liquidation Values and Debt Capacity: A Market Equilibrium Approach, *Journal of Finance*, 47(4), 1343-1365.
- [38] Senbet, L. and J. Seward, 1995, Financial Distress, Bankruptcy and Reorganization, in Jarrow, R., Maksimovic V. and W. Ziemba, (eds.), *Handbook of Finance*.
- [39] Stulz, R., 1990, Managerial Discretion and Optimal Financing Policies, *Journal of Financial Economics*, 26, 3-27.
- [40] Titman, S., 1984, The Effect of Financial Structure on a Firm's Liquidation Decision, *Journal of Financial Economics*, 13, 137-151.
- [41] Warner, J., 1977, Bankruptcy, Absolute Priority, and the Pricing of Risky Debt Claims, *Journal of Financial Economics*, 4, 239-276.

Weiss, L., 1990, Bankruptcy Resolution: Direct Costs and the Violation of Priority of claims, *Journal of Financial Economics*, 27, 285-314.

Table 1
Chapter 11 Bankruptcy Sample Characteristics

Sample characteristics of plants of bankrupt firms which declared Chapter 11 in the years 1978-1989. Plant-level data is obtained from the Annual Survey of Manufactures (ASM) from the Bureau of the Census, U.S. Department of Commerce. Total factor productivity (TFP) statistics are given for the year prior to the declaration of Chapter 11 for each of the bankrupt firms. TFP is a relative measure of productivity calculated such that average TFP over time equals zero. TFPs are standardized by dividing each TFP by the standard deviation of the industry's TFP at the 4 digit level. Shipment or Output change is determined by using aggregate industry data from the National Bureau of Economic Research (NBER) for manufacturing industries. Quartiles are determined by computing the change in the real value of shipments over 10 years at the 3 digit SIC code level. (Standard error of the mean is in parentheses.)

Sample of Firms		
	Bankrupt Firms	Non-bankrupt Industry Firms
Number of Plants ^a (302 Bankrupt Firms)	1,075	56,256
Average Plant Size (Value of Shipments - \$ Millions)	61.954	29.764
Average Plant Age (Years) ^b Standard Error of Mean	11.5 (.154)	8.24 (.025)
Total Factor Productivity: Year before Chapter 11 Ave. Standardized TFP (Bankrupt - Industry Ave.) Standard Error of Mean	-0.048* (.0282)	
<u>Statistics by Growth in Industry Shipments Quartile</u>		
Quartile 1 : Number of Plants	259	8,021
% of Industry Plants in Bankruptcy	3.23%	
Median Growth in Real Industry Shipments:	-33.93%	
Quartile 2 : Number of Plants	457	18,089
% of Industry Plants in Bankruptcy	2.53%	
Median Growth in Real Industry Shipments:	-4.12%	
Quartile 3 : Number of Plants	199	12,978
% of Industry Plants in Bankruptcy	1.53%	
Median Growth in Real Industry Shipments:	8.11%	
Quartile 4 : Number of Plants	160	16,295
% of Industry Plants in Bankruptcy	0.98%	
Median Growth in Real Industry Shipments:	23.14%	

* Significantly different from zero at the 10% level using a two-tailed test for the difference of the mean from zero.

^a We use the year of the first bankruptcy in an industry when there are multiple bankruptcies in an industry for the number of non-bankrupt industry firms and industry plants.

^b Average plant age is calculated as the year before Chapter 11 less the first time the plant appeared in the database starting with 1972. We checked back as far as the 1972 Census of Manufactures for plant births.

Table 2
Productivity of Plants of Chapter 11 Firms

This table presents summary statistics that examine whether the productivity and number of plants of bankrupt firms varied over aggregate industry quartiles defined by change in industry demand over the 10 year period using the change in 3 year averages for 1977-1979 to 1986-1988. Numbers are average relative Total Factor Productivity (TFP) less the industry average TFP for firms which declared chapter 11 in the years 1977-1989. TFPs are standardized by dividing each TFP by the standard deviation of the industry TFPs at the 4 digit SIC code level. Quartiles are determined by using aggregate industry shipment data from the National Bureau of Economic Research (NBER) for manufacturing industries. The industry shipment data is the real value of shipments at the 3 digit SIC code. (T-statistics for significant difference from zero are in parentheses.)

All Firms				by Industry Growth Quartile				t-stat. for significant
n				Q1	n	Q4	n	difference for 44-41
Average productivity				(lowest quartile)				
Panel A: Years Before Chapter 11								
Year -2	-0.044	1188		-0.052	308	-0.009	196	(0.47)
	(-1.53)			(-1.04)		(-0.12)		
Year -1	-0.048 ^c	1075		-0.032	259	-0.151 ^c	160	(-1.14)
	(-1.70)			(-0.53)		(-1.70)		
Panel B: In Chapter 11								
Year 0	-0.092 ^a	873		-0.118 ^c	207	-0.188	154	(-0.56)
t-stat for average	(-2.51)			(-1.73)		(-1.46)		
t-stat for -1 to 0	(-0.89)			(-0.98)		(-0.24)		
Year +1	0.036	639		0.086	156	0.015	102	(-1.26)
t-stat for average	(0.86)			(1.06)		(0.13)		
t-stat for -1 to +1	(1.67)			(1.20)		(1.14)		
Year +2	-0.024	345		0.072	99	-0.237 ^b	61	(-1.98) ^b
t-stat for average	(-0.51)			(0.72)		(-1.74)		
t-stat for -1 to +2	(0.42)			(1.04)		(-0.53)		
Year +3	-0.071	200		0.027	72	-0.369 ^a	29	(-2.62) ^a
t-stat for average	(-1.14)			(0.31)		(-2.47)		
t-stat for -1 to +3	(-0.33)			(0.57)		(-1.26)		
Year +4	-0.023	143		0.093	56	-0.335 ^a	24	(-2.40) ^a
t-stat for average	(-0.31)			(0.87)		(-2.66)		
t-stat for -1 to +4	(0.33)			(1.03)		(-1.19)		
Panel C: After Emergence from Chapter 11								
Year +1	-0.123 ^c	372		-0.055 ^c	75	0.022	49	(0.44)
t-stat for average	(-1.89)			(-0.48)		(0.17)		
t-stat for -1 to +1	(-0.83)			(-0.18)		(1.13)		
Year +2	-0.093	213		-0.040	56	-0.003	34	(0.65)
t-stat for average	(-1.48)			(-0.31)		(0.02)		
t-stat for -1 to +2	(-0.65)			(-0.06)		(0.90)		
Year +3	-0.165 ^c	124		-0.003	28	-0.288	30	(-0.63)
t-stat for average	(-1.63)			(-0.01)		(-1.47)		
t-stat for -1 to +3	(-1.11)			(0.10)		(-0.64)		

Table 3
Productivity Controlling for Composition Changes

This table presents the prior productivity of plants by the number of years in Chapter 11, for industry growth quartiles 1 and 4. The table thus directly controls for changing asset composition. Plants leave Chapter 11 because they are sold off, close down or because the firm emerges from Chapter 11. Numbers are plant-level Total Factor Productivity (TFP) less the industry average TFP for firms which declared chapter 11 in the years 1978-1989. TFPs are standardized by dividing each TFP by the standard deviation of the industry TFPs at the 4 digit SIC code level. Quartiles are determined by using the change in 10 year shipments at the aggregate 3 digit SIC code level for all industries. (T-statistics for significant difference from zero are in parentheses.)

Number of years in Chapter 11	Average Year -1	Change Year -1 to 0	-1 to 1	-1 to 2	-1 to 3	-1 to 4
< 1 year, n=47	-0.293 ^b	0.068				
t-stat. for Q1*	(-2.14)	(0.31)				
1 year, n=54	-0.287 ^b	0.187	0.312			
t-stat. for Q1	(-2.19)	(0.96)	(1.48)			
2 years, n=27	-0.086	-0.110	0.252	0.240		
t-stat. for Q1	(-0.67)	(-0.55)	(1.18)	(0.23)		
3 years, n=13	0.286	-0.266	-0.172	-0.162	0.001	
t-stat. for Q1	(1.44)	(-0.86)	(-0.63)	(-0.53)	(0.01)	
4 or more, n=56	-0.078	-0.023	0.148	0.087	0.107	0.176
t-stat. for Q1	(-0.71)	(-0.21)	(1.18)	(0.88)	(1.02)	(1.55)

Industry Quartile 4: Productivity in Bankruptcy

Number of years in Chapter 11	Average Year -1	Change Year -1 to 0	-1 to 1	-1 to 2	-1 to 3	-1 to 4
< 1 year, n=20	-0.306	-0.517				
t-stat. for Q4*	(-1.61)	(-1.71) ^c				
t-stat. for 44-41*	(-0.09)	(-1.67) ^c				
1 year, n=39	-0.159	0.233	0.212			
t-stat. for 44	(-0.68)	(0.66)	(0.68)			
t-stat. for 44-41	(0.94)	(0.12)	(0.14)			
2 years, n=29	0.247	0.057	0.055	-0.352		
t-stat. for 44	(0.99)	(0.18)	(0.17)	(-1.02)		
t-stat. for 44-41	(1.40)	(0.45)	(-0.52)	(-0.54)		
3 years, n=6	-0.541	-0.239	-0.251	0.029	0.128	
t-stat. for 44	(-1.51)	(-0.60)	(-0.64)	(0.07)	(0.34)	
t-stat. for 44-41	(-2.26) ^b	(0.06)	(-0.17)	(0.40)	(0.29)	
4 or more, n=24	-0.076	-0.037	-0.048	-0.228	-0.274	-0.258
t-stat. for 44	(-0.69)	(-0.27)	(-0.37)	(-1.78) ^c	(-2.35) ^b	(-2.11) ^b
t-stat. for 44-41	(0.02)	(-0.08)	(-0.96)	(-1.84) ^c	(-2.16) ^b	(-2.32) ^b

Note: Plant counts do not add up exactly to the yearly changes in plants in Table 2 because of missing plant year data.

* Q1 represents productivity of plants in quartile 1, Q4 for quartile 4 respectively.

Q4-Q1 represents the difference in means between quartile 4 and quartile 1.

a, b, c - Significantly different from zero at the 1%, 5%, 10% level, respectively, using a two-tailed t test for the difference of the mean from zero.

	Bankrupt Firms		Industry Firms		Bankrupt Firms		Industry Firms	
	Old Owners	New Owners	Old Owners	New Owners	Old Owners	New Owners	Old Owners	New Owners
Panel A: Before Chapter 11								
Asset Sale Firms: Sales	-0.014	-0.027	-0.015	0.017	-0.065	-0.052	-0.032	-0.020
<i>t-stat for Average TFP=0</i>	(-0.26)	(-0.46)	(-0.98)	(1.23)	(-0.91)	(-0.60)	(-2.07) ^b	(-1.16)
<i>t-stat for Improvement under New Owners, relative to industry number of plants [% Sold Off]</i>	193, [41.3%]	(-2.18) ^b	706, [18.4%]*		122, [52.4%]	(0.03)	502, [13.1%]*	
Assets Retained: TFP	-0.049		0.029		-0.057		0.040	
<i>t-stat for Average TFP=0</i>	(-1.26)		(1.50)		(-1.25)		(2.28) ^b	
<i>t-stat for Retain - Sold number of plants</i>	(-0.54)		(1.78) ^c		(0.09)		(3.08) ^a	
	274		3124		111		3324	
Non-Asset Sale Firms	-0.070		-0.008		-0.016		-0.009	
<i>t-stat for Average TFP=0</i>	(-1.63)		(-1.15)		(-0.57)		(-1.23)	
	n = 434		n = 19664		n = 251		n = 16967	
Panel B: Chapter 11 Period								
Asset Sale Firms: Sales	-0.030	-0.057	-0.033	-0.008	0.011	0.080	-0.009	-0.051
<i>t-stat for Average TFP=0</i>	(-0.36)	(-1.45)	(-2.24) ^b	(-0.44)	(0.11)	(1.72) ^c	(-0.65)	(-3.33) ^a
<i>t-stat for Improvement under New Owners, relative to industry number of plants [% Sold Off]</i>	138, [44.4%]	(-1.20)	437, [20.2%]*		47, [58.8%]	(2.29) ^b	466, [19%]*	
Assets Retained: TFP	0.053		0.046		-0.209		0.035	
<i>t-stat for Average TFP=0</i>	(1.56)		(1.53)		(-2.37) ^b		(2.66) ^a	
<i>t-stat for Retain - Sold number of plants</i>	(0.93)		(2.36) ^a		(-1.66) ^c		(2.34) ^b	
	172		1726		33		1983	
Non-Asset Sale Firms	0.064		-0.002		-0.154		-0.005	
<i>t-stat for Average TFP=0</i>	(1.19)		(-0.26)		(-1.38)		(-0.68)	
<i>number of plants</i>	258		21592		120		19738	
Panel C: After Chapter 11								
Assets Retained	0.006		0.027		-0.167		0.020	
<i>t-stat for Average TFP=0</i>	(0.15)		(2.50) ^a		(-1.72) ^c		(2.50) ^a	
<i>number of plants</i>	n = 167		n = 1472		n = 85		n = 1807	

Productivity of Purchaser	(lowest 2 quartiles)				(highest 2 quartiles)			
	Quartile 1	number of plts.	Quartile 2	number of plts.	Quartile 3	number of plts.	Quartile 4	number of plts.
Before Purchase	0.010	1826	0.080	3464	0.020	3176	0.092	2129
<i>t-stat for Average TFP=0</i>	(0.42)		(5.07) ^a		(1.32)		(4.43) ^a	
After Purchase	0.057	1203	0.057	2939	0.017	2734	0.053	1540
<i>t-stat for Average TFP=0</i>	(1.95) ^b		(3.11) ^a		(0.97)		(2.01) ^b	

Table 5
Asset Sale Decisions

Regressions test the effects of plant-level productivity and industry-level demand and supply variables on asset sale decisions of bankrupt firms and other non-bankrupt industry firms. Regressions are estimated using a logistic limited dependent variable model. The dependent variable equals 1 if a plant is sold in that year. The change in industry shipments and capacity utilization are yearly at the 4 digit SIC code level. Weighted Industry R&D is from COMPUSTAT firm-level data and represents R&D and advertising expense divided firm sales aggregated up to the 3 digit SIC code. Total Factor Productivity (TFP) is calculated using a translog production function. Operating Cash flow is the value of shipments less labor, materials and energy costs by value of shipments. Plant scale is the plant's asset size divided by the average assets for plants in each industry. Data are yearly from 1977-1990. (P-values are in parentheses.)

Variable	Dependent Variable: Plant Asset Sale			test for Significant Diff.
	Logit A: Full Sample	Logit B: Quartile 1	Logit C: Quartile 4	Quartile 4 - Quartile 1 (p-value)
Industry-level Variables				
Change in Industry Shipments	1.141 (.000) ^a	0.983 (.006) ^a	0.538 (.161)	(.000) ^a
Weighted Industry R&D	1.935 (.000) ^a	9.675 (.000) ^a	0.256 (.773)	(.000) ^a
Capacity Utilization	-0.015 (.000) ^a	-0.010 (.000) ^a	-0.005 (.129)	(.135)
Standard Dev. of Industry Shipments	-4.744 (.000) ^a	1.381 (.170)	-3.489 (.001) ^a	(.002) ^a
Plant- and Firm-level Variables				
(Variables lagged one year)				
Number of Plants Owned by Firm	-0.005 (.000) ^a	-0.009 (.000) ^a	0.000 (.839)	(.000) ^a
Log of Firm Shipments	0.382 (.000) ^a	0.404 (.000) ^a	0.378 (.000) ^a	(.399)
Total Factor Productivity (TFP) (Lagged one year)	-0.168 (.000) ^a	-0.130 (.005) ^a	-0.132 (.000) ^a	(.207)
Plant-level Operating Cash Flow (Lagged one year)	0.173 (.007) ^a	0.017 (.901)	0.339 (.010) ^a	(.115)
Relative Plant Scale	-0.154 (.000) ^a	-0.167 (.000) ^a	-0.171 (.000) ^a	(.905)
Plant Age	0.020 (.000) ^a	0.037 (.000) ^a	0.019 (.000) ^a	(.006) ^a
Bankruptcy Variables				
Before Chapter 11 dummy variable (=1 for years before firm is in Chapter 11)	0.602 (.000) ^a	0.275 (.073) ^c	0.266 (.209)	(.751)
In Chapter 11 dummy variable (=1 while firm is in Chapter 11)	0.409 (.198)	-0.068 (.963)	0.654 (.321)	(.332)
After Chapter 11 dummy variable (=1 after firm emerges from Chapter 11)	-0.119 (.583)	-0.950 (.184)	-0.465 (.474)	(.693)
In Chapter 11 * TFP	0.251 (.135)	0.483 (.214)	0.680 (.082) ^c	(.900)
In Chapter 11 * Cash Flow (firm cash flow in last 3 columns)	-0.737 (.163)	-1.368 (.115)	-3.209 (.042) ^b	(.146)
In Chapter 11 * Industry R&D	0.757 (.845)	22.800 (.080) ^c	-14.718 (.088) ^c	(.010) ^a
In Chapter 11 * Change in Shipments	0.467 (.801)	-2.786 (.358)	5.259 (.012) ^b	(.014) ^b
In Chapter 11 * Capacity Utilization	-0.004 (.315)	-0.010 (.581)	0.009 (.369)	(.365)
Total Plant Years	371,373	60,477	85,148	
Chi-Squared Statistic	4370.57	653.20	1255.57	
Significance Level (p-value)	<1%	<1%	<1%	

a,b,c - significantly different from zero at the 1%, 5%, and 10% level of significance, respectively, using a two-tailed t-test.

Table 6
Plant Asset Sales: Estimated Probabilities

Estimated probabilities of an asset sale by bankrupt and non-bankrupt firms at the 10th, 25th, 50th and 90th percentiles of total factor productivity (TFP). Estimated probabilities are computed using the coefficients from the logit regression predicting asset sales. Probabilities are computed holding all other variables besides TFP and TFP interaction terms at the sample means of the non-bankrupt firms and the bankrupt firms. For the year $t-1$, the non-bankrupt firms and the bankrupt firms probabilities are computed with the before bankruptcy indicator variable equal to zero and one respectively. For the year $t+1$ for the bankrupt firm, we include the during bankruptcy indicator variable and the interactions with the industry and productivity variables.

Total Factor Productivity	Probability at:			
	TFP	TFP	TFP	TFP
	10th Percentile	25th Percentile	50th Percentile	90th Percentile

Probabilities from Table 5 Logit Regression A:

Variables taken at the non-bankrupt/ bankrupt sample means:

Panel A:

Bankrupt firm: (data from bankrupt sample)	Year $t-1$	7.65%	7.06%	6.57%	5.59%
	Year $t+1$	4.91%	5.16%	5.39%	5.88%
Bankrupt firm: (data from non-bankrupt sample)	Year $t-1$	3.15%	2.91%	2.70%	2.25%
	Year $t+1$	2.16%	2.25%	2.33%	2.54%
Non-Bankrupt firm: (data from non-bankrupt sample)	Year $t-1$	1.75%	1.62%	1.50%	1.25%
	Year $t+1$	1.85%	1.70%	1.57%	1.31%
Non-Bankrupt firm: (data from bankrupt sample)	Year $t-1$	4.34%	3.99%	3.71%	3.14%
	Year $t+1$	4.46%	4.02%	3.68%	3.06%

Probabilities from Table 5 Logit Regressions B and C by Quartile: ^a

Variables taken at the bankrupt sample mean:

Panel B:

Quartile 1: bankrupt firm	Year $t-1$	4.90%	4.62%	4.35%	3.74%
	Year $t+1$	2.55%	3.23%	3.93%	5.70%
Quartile 1: non-bankrupt firm	Year $t-1$	4.48%	4.14%	3.81%	3.14%
	Year $t+1$	3.64%	3.28%	2.90%	2.22%
Quartile 4: bankrupt firm	Year $t-1$	8.09%	7.51%	6.92%	5.74%
	Year $t+1$	3.74%	4.22%	4.87%	6.64%
Quartile 4: non-bankrupt firm	Year $t-1$	4.78%	4.51%	4.25%	3.66%
	Year $t+1$	4.86%	4.45%	4.15%	3.61%

^a For quartiles the percentiles refer to that specific subsample. Thus the 50th percentile for Quartile 1 is the 12.5th percentile of the overall sample. In addition, for each quartile we use the means of the data for that quartile for all of the other independent variables and use the coefficients from the logit regressions by quartile to calculate the probability of asset sale.

Table 7
Plant Closures by Chapter 11 Firms

This table examines the productivity of firms' plants that were closed by firms that declared Chapter 11 and industry plants in the same 4 digit SIC code. Industry quartiles are formed using external industry data from the NBER and represent the change in shipments over a ten year period at the 3 digit SIC code level. TFPs are standardized by dividing each plant-level TFP by the standard deviation of industry TFP at the 4 digit SIC SIC code level. Years after emergence are combined for bottom 2 and top 2 quartiles because of disclosure restrictions. (T-statistics are in parentheses.)

Plant-level Productivity for Year of Closure by Shipments Change Quartile

Plant Closures	1 n1		2 n2		3 n3		4 n4		-statistic for
	lowest quartile)				(highest quartile)				Q4-Q1
<u>Before Chapter 11</u>									
Bankrupt Firms	-0.437	57	-0.296	71	-0.372	30	-0.483	21	(-0.18)
	(-3.12) ^a		(-2.31) ^b		(-1.92) ^c		(-2.16) ^c		
%Closed [•]	18.0%		13.4%		13.1%		11.5%		
Industry Firms	-0.329	660	-0.220	1084	-0.298	848	-0.339	539	(-0.14)
<i>t-stat.for average=0</i>	(-7.13) ^a		(-5.90) ^a		(-5.39) ^a		(-5.85) ^a		
%Closed [•]	7.5%		5.4%		6.3%		3.2%		
<i>t -statisticfor Bankrupt-Industry=0</i>	(-0.73)		(-0.57)		(-0.37)		(-0.62)		
<u>Chapter 11 Period</u>									
Bankrupt Firms	-0.040	18	-0.575	20	-0.127	12	-0.829	9	(-1.84) ^c
<i>t-stat.for average=0</i>	(-0.16)		(-3.40) ^a		(-0.43)		(-4.09) ^a		
%Closed [•]	6.5%		4.2%		5.7%		5.3%		
Industry Firms	-0.412	350	-0.331	667	-0.259	376	-0.212	325	(1.96) ^b
<i>t-stat.for average=0</i>	(-5.99) ^a		(-6.69) ^a		(-3.77) ^a		(-2.80) ^a		
%Closed [•]	4.1%		3.4%		2.9%		2.0%		
<i>t -statisticfor Bankrupt-Industry=0</i>	(1.46)		(-1.38)		(0.43)		(-2.85) ^a		
<u>After Emergence from Chapter 11</u>									
	<u>Quartiles 1 and 2</u>				<u>Quartiles 3 and 4</u>				
Bankrupt Firms	-0.131	11			-0.633	7			(-0.99)
<i>t-stat.for average=0</i>	(-0.48)				(-1.86) ^c				
Industry Firms	-0.288	811			-0.234	1073			(0.93)
<i>t-stat.for average=0</i>	(-6.49) ^a				(-6.35) ^a				
<i>t -statisticfor Bankrupt-Industry=0</i>	(0.57)				(-1.17)				

* For pre-bankruptcy period, % closed is closures divided by the number of plants 4 years prior to bankruptcy. For the Chapter 11 period closures are divided by the number of plants in the year the firm entered Chapter 11. Note, for many firms the number of years in Chapter 11 can be as low as 1 year, giving a varying number of years in which to close plants.

a, b, c - Significantly different from zero at the 1%, 5%, 10% level, respectively, using a two-tailed t test.

Table 8
Plant Closing Decisions

Regressions test the effects of plant-level productivity and industry-level demand and supply variables on plant closing decisions of bankrupt firms and non-bankrupt industry firms. Regressions are estimated using a logistic limited dependent variable model. The dependent variable equals 1 if a plant is closed in that year. The change in industry shipments and capacity utilization are yearly at the 4 digit SIC code level. Weighted Industry R&D is from COMPUSTAT firm-level and represents R&D and advertising expense divided firm sales aggregated up to the 3 digit SIC code. Total Factor Productivity (TFP) is calculated using a translog production function. Operating Cash flow is the value of shipments less labor, materials and energy costs divided by value of shipments. Plant scale is the plant's asset size divided by the average assets for plants in each industry. Data are yearly from 1977-1990. (P-values are in parentheses.)

Assets for plants in each industry. Data are yearly from 1977-1996. (t-values are in parentheses.)				
Variable	Dependent Variable: Plant Closing			Test for Significant Diff.
	Logit A: Full Sample	Logit B: Quartile 1	Logit C: Quartile 4	Quartile4 - Quartile 1 (p-value)
Industry-level Variables				
Change in Industry Shipments	-1.581 (.000) ^a	-1.304 (.002) ^a	-2.135 (.000) ^a	(.018) ^b
Weighted Industry R&D	-7.360 (.000) ^a	-3.286 (.014) ^a	-2.904 (.038) ^b	(.015) ^b
Capacity Utilization	-0.006 (.000) ^a	-0.007 (.006) ^a	0.001 (.214)	(.396)
Standard Dev. of Industry Shipme	3.783 (.000) ^a	3.256 (.000) ^a	12.00 (.000) ^a	(.000) ^a
Plant- and Firm-level Variables				
(Variables lagged one year)				
Number of Plants Owned by Firm	0.006 (.000) ^a	0.005 (.000) ^a	0.007 (.000) ^a	(.556)
Log of Firm Shipments	-0.048 (.000) ^a	-0.066 (.000) ^a	-0.027 (.160)	(.429)
Total Factor Productivity (TFP)	-0.173 (.000) ^a	-0.162 (.000) ^a	-0.279 (.000) ^a	(.000) ^a
Plant-level Operating Cash Flow	-0.147 (.002) ^a	-0.158 (.014) ^b	-0.097 (.296)	(.226)
Relative Plant Scale	-0.276 (.000) ^a	-0.286 (.000) ^a	-0.463 (.000) ^a	(.000) ^a
Plant Age	-0.022 (.000) ^a	-0.026 (.000) ^a	-0.030 (.000) ^a	(.261)
Bankruptcy Variables				
Before Chapter 11 dummy variable (=1 for years before firm is in Chapter 11)	0.681 (.000) ^a	0.692 (.000) ^a	0.944 (.000) ^a	(.663)
In Chapter 11 dummy variable (=1 while firm is in Chapter 11)	-0.123 (.916)	-2.019 (.384)	-0.473 (.889)	(.899)
After Chapter 11 dummy variable (=1 after firm emerges from Chapter 11)	0.382 (.007) ^a	-0.136 (.787)	0.529 (.002) ^a	(.056) ^b
In Chapter 11* TFP	-0.543 (.146)	-0.394 (.351)	-0.808 (.047) ^b	(.417)
In Chapter 11*Cash Flow	-0.804 (.189)	-0.293 (.751)	-0.418 (.351)	(.966)
In Chapter 11* Industry R&D	-23.915 (.015) ^b	-70.289 (.008) ^a	-41.85 (.069) ^c	(.008) ^a
In Chapter 11* Change in Shipments	-3.072 (.035) ^b	-9.213 (.054) ^c	-10.51 (.025) ^b	(.393)
In Chapter 11* Capacity Utilization	0.007 (.216)	0.032 (.262)	0.031 (.452)	(.337)
Total Plant Years	371,373	60,477	85,148	
Chi-Squared Statistic	1299.79	145.33	463.81	
Significance Level (p-value)	<1%	<1%	<1%	

Table 9
Plant Closures: Estimated Probabilities

Estimated probabilities of an asset sale by bankrupt and non-bankrupt **firms** at the 10th, 25th, 50th and 90th percentiles of the change in industry shipments. Estimated probabilities are computed using the coefficients from the logit regressions predicting plant closure. Probabilities are computed holding all other variables besides change in shipments are at the sample means of the non-bankrupt **firms** and the bankrupt **firms**. For the year t-1, the non-bankrupt **firms** and the bankrupt **firms** probabilities are computed with the before bankruptcy indicator variable equal to zero and one respectively. For the year t+1 for the bankrupt **firm**, we include the during bankruptcy indicator variable and the interactions with the industry and productivity variables.

Change in Industry Shipments (Chg. Ship)	Probability at:			
	10th Percentile	25th Percentile	50th Percentile	90th Percentile

Probabilities from Table 8 Logit regression **A** for full sample and regressions B & C for Quartiles:

Variables taken at the non-bankrupt / bankrupt sample means:

Bankrupt firm : All Quartiles	Yeart- 1	3.65%	3.36%	3.11%	2.58%
(data from bankrupt sample)	Yeart+ 1	5.21%	2.55%	1.45%	0.40%
Quartile 1 ^a	Yeart+ 1	13.92%	11.20%	9.10%	5.79%
Quartile4 ^a	Yeart+ 1	1.13%	0.65%	0.38%	0.11%
Bankrupt firm : All Quartiles	Yeart- 1	3.38%	3.10%	2.86%	2.41%
(data from non-bankrupt sample)	Yeart+ 1	4.64%	2.43%	1.25%	0.32%
Quartile 1 ^a	Yeart+ 1	13.71%	10.20%	7.95%	4.82%
Quartile4 ^a	Yeart+1	1.03%	0.59%	0.30%	0.10%
Non-Bankrupt firm :	Yeart- 1	1.74%	1.59%	1.47%	1.24%
(data from non-bankrupt sample)	Yeart+ 1	1.68%	1.51%	1.37%	1.13%
Non-Bankrupt firm :	Yeart- 1	1.88%	1.73%	1.64%	1.33%
(data from bankrupt sample)	Yeart+ 1	1.89%	1.73%	1.60%	1.32%

- ^a For quartiles the percentiles refer to that specific subsample. Thus the 50th percentile for Quartile 1 is the 12.5th percentile of the overall sample. In addition, for each quartile we use the means of the data for that quartile for all of the other independent variables and use the coefficients from the logit regressions by quartile to calculate the probability of closure.

Table 10

Transfers to Chapter 7 Liquidation

This table examines the productivity of firms' plants that transferred into Chapter 7 liquidation from Chapter 11 compared to the remaining Chapter 11 firms that do not enter Chapter 7. Numbers are relative Total Factor Productivity (TFP) for plants less the industry average TFP for each year. TFPs are standardized by dividing by the standard deviation of industry TFP at the 4 digit SIC code level. Quartiles are determined by using the change in the real value of shipments at the 3 digit SIC code from the National Bureau of Economic Research (NBER). Productivity (TFP) numbers are presented combining the bottom and top two quartiles to obtain sufficient numbers of plants to allow disclosure. (T-statistics are in parentheses.)

	Growth in Shipments: Lowest 2 Quartiles				Highest 2 Quartiles			
	Chapter 11 Firms*	n	Ch. 11 Firms transferred to Chapter 7	n	Chapter 11 Firms*	n	Ch. 11 Firms transferred to Chapter 7	n
Average productivity								
Panel A: Years Before Chapter 11								
Year -2	-0.031	636	-0.219	146	0.046	330	-0.198	76
	(-0.82)		(-2.81) ^a		(0.88)		(-1.75) ^c	
Year -1	-0.036	607	-0.098	109	-0.019	295	-0.189	64
	(-1.04)		(-1.20)		(-0.33)		(-1.38)	
Panel B: After Declaration of Chapter 11								
Year 0	-0.100	514	-0.070	24	-0.046	299	-0.347	36
t-stat for average	(-2.35) ^c		(-0.40)		(-0.77)		(-2.58) ^a	
t-stat for -1 to 0	(-1.15)		(0.15)		(-0.32)		(-0.82)	
Year +1	0.046	412	-0.105	13	0.016	209		
t-stat for average	(0.89)		(-0.41)		(0.19)			
t-stat for -1 to +1	(1.32)		(-0.03)		(0.37)			
Year +2	0.026	208			-0.073	129		
t-stat for average	(0.46)				(-0.78)			
t-stat for -1 to +2	(0.93)				(-0.58)			
Year +3	0.048	133			-0.336	59		
t-stat for average	(0.62)				(-2.49) ^a			
t-stat for -1 to +3	(0.99)				(-2.96) ^a			
Year +4	0.072	85			-0.177	49		
t-stat for average	(0.76)				(-1.32)			
t-stat for -1 to +4	(1.07)				(-1.28)			
Panel C: After Leaving Chapter 11, Emerged Firms vs. Firms transferred to Chapter 7***								
Year +1	-0.087	260	-0.274	80	-0.207	112	-0.131	38
t-stat for average	(-1.41)		(-2.89) ^a		(-2.32) ^b		(-0.97)	
t-stat for -1 to +1	(-0.71)		(-1.40)		(-1.78) ^c		(0.31)	
Year +2	-0.104	136	-0.197	69	-0.073	77	-0.409	17
t-stat for average	(-1.21)		(-1.65) ^c		(-0.86)		(-1.99) ^c	
t-stat for -1 to +2	(-0.73)		(-0.68)		(-0.53)		(-0.64)	
Year +3	-0.126	75	-0.389	69	-0.226	49	-0.583	15
t-stat for average	(-0.92)		(-3.50) ^a		(-1.51)		(-2.67) ^a	
t-stat for -1 to +3	(-0.63)		(-2.11) ^b		(-1.29)		(-1.53)	

- means that the cell cannot be disclosed because there are too few plants in this relative year.

* The Chapter 11 firms in this column are the subset of Chapter 11 firms that do not transfer to Chapter 7.

** Columns 1 and 3 represent the years after Chapter 11 for firms emerging from bankruptcy. Columns 2 and 4 represent the years in Chapter 7 after transferring from Chapter 11 for the bottom 2 and top 2 quartiles, respectively. We assign firms to Chapter 7 based on the year end status, thus some firms transfer to Chapter 7 within the same year of declaring Chapter 11.